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Technical Education and Industry.

REPEATEDLY in these columns we have urged a revision of traditional philosophies of education. We have shown that, as a result of the transition from a non-scientific to a scientific basis of civilisation, vast powers have been placed in man's hands—powers by which life can be freed from unnecessary toil, and denuded of the harmful mysticisms, superstitions, and pruderies which cramp its social, political, and ethical qualities. Far from making recommendations which would tend to a system of education built merely upon an arid, mechanical efficiency, we have insisted that a knowledge of the truth of the natural world as shown through physics, chemistry, astronomy, and like subjects, and a knowledge of the truth of man's place and relationships in the scale of life as shown through subjects such as biology, is not incompatible with, but the sound basis of, an appreciation of beauty whether enshrined in literature, art, or an ordered state which understands race experience sufficiently to be able consciously to control its future experience.

So much for what might be called fundamentals. They may be regarded by an instinctively (and, in some respects, rightly) conservative academia as involving changes too sweeping to be practised until the present machinery of civilisation can absorb them. We agree that there may be something in the objection. We realise that the vast body of new knowledge which science has produced during the last twenty years or so and thrust into practical use in social, industrial, and commercial fields has not yet been grasped by legislators, teachers, and business men. We cannot avoid noticing, for example, the unconscious legal cruelty which may arise from failure to discern the dividing lines between the scopes of law, medicine, and sociology. Nor can we fail to observe how great issues which will shape the future are constantly fogged or misdirected by ignorance. The vast forces of science have not yet been co-ordinated and absorbed by the dominating operators of our social mechanism so that the community may reap the benefit. But although it is clear that, in spite of a recent suggestion, it is impossible to call a temporary halt in the world of science, we can sympathise with the view that its discoveries and implications must be more widely understood if order is to be brought out of the present chaos.

Obviously, the production of that order will be a slow progress: obviously, it must depend upon a system of education carefully planned with the

view of a better social order. These are facts which must be faced steadily. But a carefully planned system of education will not, in itself, solve our difficulties. The welfare of Great Britain and its institutions rests ultimately on the success of its industry. That is another incontrovertible fact. Teachers have been reminded of it frequently; but it must be faced equally by those responsible for the successful development of industry itself.

For the benefit of the mind careful to the point of fearfulness, we would point out that, in urging a revision of educational notions, we have not presented suggestions which have been unduly hurried. Those suggestions have found reflection in the reports of bodies appointed to examine important aspects of our present discontents. We have, for example, commented in previous issues upon the findings of the Hadow, Malcolm, and Balfour Committees. In all these reports the need for strengthening the link between education and industry has been emphasised. That emphasis has not come only from official committees. On all sides enlightened teachers and leaders of industry have been seeking to join forces. The Emmott Committee of Inquiry into Technical Education and Industry has been, perhaps, the venue of the most varied representatives desiring to commence the solution of this particular problem; and at the recent meeting of the British Association, education and industry was a subject to which a complete session was devoted. Papers read by educationists and industrialists showed clearly that their interdependence is realised by both sides. Especially was it made clear that educational machinery, capable of great development, already exists to supply the requirements of industry, even though no national administrative machinery, through which both sides can adequately express their needs, has yet been formulated. Clearly, however, the *rapprochement* of education and industry has commenced.

The papers to which we have referred were well selected. From the educationist's point of view, arguments were presented for the grouping of social, industrial, and educational problems; the work, general difficulties, and possibilities of a typical technical institution were outlined; the results and advantages obtained by a college which trains engineers on a definite production basis rather than an 'exercise' basis were described. From the industrialist's point of view, criticism of present elementary and secondary school curricula was advanced and a plea was made for a revision which might give capable managers and workers to industry no less than balanced and thoughtful citizens to society; suggestions were made as to industry's contribution of forms of essential education not always included in the formal processes of the school. Altogether, we gained a very satisfactory impression that ancient antagonisms are disappearing, and that, since the industrialist has now realised the value—commercial as well as social—of education to his industry, and since the teacher—at least on the technological side—is prepared to shape his work in the wide interests of industry, it appeared to be but a matter of time until the resulting benefits will be enjoyed by student, worker, teacher, and employer.

We must pause here, however, and examine present facts, and not be swept away from them by pleasant speeches and urbane agreements. Industry has commenced to demand men and women soundly educated and expertly trained for its tasks. The educationist has answered by producing from his universities and technical institutions the type of student the industrialist tells him, and which he believes, is required. But if industry has correctly expressed its needs, and education can fulfil those needs, there ought not to be the slightest difficulty in placing every properly qualified student. That is surely an 'acid test' of the relationship between school and employment.

What, however, are the present facts? In chemical industry, for example, we have been told that there is an almost unlimited field for the technically trained man or woman. But those of us who have some knowledge of the number of graduates in chemistry leaving universities and technical institutions also know the difficulties they often have in securing satisfactory employment. How many graduates in engineering, too, have been able to secure positions in which their training can be adequately used? On the commercial side we recall the demand made by employers for highly trained and broad-visioned employees which resulted in the institution of the Bachelor of Commerce degree; but we have not lacked evidence that possessors of that qualification have not found it easy to secure posts in competition with applicants of no other training than that of commercial experience since the age of fourteen years. It is not to be doubted, we think, that there are well-qualified men and women unable to find openings in industry and commerce, and although we realise that the problem of employment has many aspects, we feel bound to ask

whether employers are prepared *now* to take advantage of education's newest product.

It would clearly be a doubtful move to extend the facilities for special training if the present output cannot be absorbed. Are there, then, sufficient openings at present to justify the extension of facilities for which employers ask? Do the majority of employers sufficiently realise the advantage of securing the well-trained recruit? The employer who has done so seems to be the established and, perhaps, leading industrialist who presents what is assumed to be a complete industrial view before public meetings and official and other committees. But what of the employers of whom we hear but little and who have not yet understood the sound benefits which can be secured from trained workers? If it be answered that all employers understand those benefits, then the difficulty of securing employment must be traced to a weakness lying elsewhere. For, clearly, while the present position continues we cannot avoid the conclusion that the weakness lies either in education or in industry. If it be in education, the employer should indicate it with all speed: if it be in the organisation and methods of industry, they must either be altered or else clear instructions, based upon them, must be submitted for the consideration of educationists.

There is certainly one point arising out of the organisation of industry which was touched upon during the British Association discussion by an educational and by an industrial representative. The former referred to the growing impression that promotion to the higher posts in engineering proceeded more readily from the office than from the works, and that this industry is already losing heavily by bribing its best boys into the administrative rather than the production side. The latter underlined the same complaint. No amount of inducement, he said, seemed able to overcome what appears to have become a distinct difference in status. This fault of shaping the bright boy to the black suit was regarded as belonging to parents and teachers rather than to employers. But are parents and teachers to receive all the blame? Is it not generally true that difference of status exists? Is it not generally true that in times of bad trade it is the production side which suffers while the administrative side enjoys something very like permanence? Can the employer help to avoid this—a very real threat to the future skill and welfare of industry?

We hope we shall not be misunderstood. We have sketched the need for an educational system which shall fit modern civilisation particularly through its effect of wiping away the ignorance which may fog and warp the issues which are shaping the future. We have insisted that the linking of education and industry is an essential part of that new system. We have welcomed the evidence which shows that its necessity is being more and more realised; and if we have paused to examine present difficulties which tend towards the nullification of the promise that evidence holds out, we have not done so merely to apportion blame or praise to any particular quarter. It is simply that, in our earnest desire that these new and beneficial movements shall proceed unhampered, we have attempted to indicate some barriers which need speedy removal.

Science and Theology.

(1) *Concerning Man's Origin: being the Presidential Address given at the Meeting of the British Association held in Leeds on Aug. 31, 1927, and recent Essays on Darwinian Subjects.* By Sir Arthur Keith. (The Forum Series.) Pp. ix + 54. (London: Watts and Co., 1927.) 1*s.* net.

(2) *Religion without Revelation.* By J. S. Huxley. (What I Believe Series.) Pp. 392. (London: Ernest Benn, Ltd., 1927.) 8*s.* 6*d.* net.

(3) *The Church and Science: a Study of the Interrelation of Theological and Scientific Thought.* By Dr. Hector Macpherson. (The Living Church Series.) Pp. 254. (London: James Clarke and Co., Ltd., 1927.) 6*s.* net.

(1) SIR ARTHUR KEITH, in a foreword to his presidential address to the British Association, just published by Messrs. Watts and Co., makes a notable observation. He writes that although the outburst in the public press which followed his defence of Darwinism indicated "that Daytonism is very much alive throughout the land, and that the only science people are prepared to accept is that enshrined in the book of Genesis," yet, that he was encouraged by the reception given to his address by the leaders of religious thought. The words in which he places this upon record are sufficiently important to quote in full:

"Far from being in opposition, they want to know all that can be known of the universe in which we live, and of that remarkable aberrant product of Nature which we call Man. They have grown up in the post-Darwinian period, and no longer regard the great army of science as an enemy, but as a friendly power. They realise that religion cannot stand still, that it too must evolve, and that it is the duty of theologians not to expect scientific men

to modify their facts to fit religious views, but that religion must be modified to fit man's changing needs, and to be in keeping with the truth as revealed by scientific inquiry. It may take long before we reach perfect accord, but nothing but good can come out of a working agreement effected between men who are striving for the betterment of humanity through an increase of well-ascertained knowledge. Religious leaders and men of science have the same ideals; they want to understand and explain the universe of which they are part; they both earnestly desire to solve, if a solution is ever possible, that great riddle: Why are we here?"

Sir Arthur Keith is undoubtedly justified in believing that religious leaders, so far as the natural sciences are concerned, are by no means reluctant to accept new ideas. If this is gratifying to men of science, it is equally encouraging to theologians to observe among men of science an increasing tendency to take religion seriously and to attach importance to the religious view of life. Nor is this the case only, as might perhaps have been expected, among anthropologists and psychologists, to whose subject matter religion belongs; it is no less conspicuous among physicists and biologists.

(2) Among biologists, the latest example of one taking an interest in the religious problem is Prof. J. S. Huxley, who has published his views in a volume entitled "Religion without Revelation." The book is inspired by the belief that

"One of the most urgent needs of humanity at the present time is a common outlook, comparable in its comprehensiveness and wide acceptance with the common outlook, religious and philosophical, which dominated the Middle Ages."

Prof. Huxley does not fail to indicate what he believes should be the foundations of a reformed theology; these will be threefold, and will consist "of agnosticism, of evolutionary natural science, and of psychology." We may presume that the word agnosticism is used in a wide and general sense to describe an attitude which is mistrustful of all dogmatic systems, positive or negative, which are prisons of the mind. With regard to evolutionary science, Sir Arthur Keith's address makes it clear that Darwin's theory of man's origin is not only unshaken but unshakeable; and we may take it that the evolutionary outlook has come to stay. As for psychology, it is clear that a systematic study of the facts of religious experience is a necessary basis of any sound theology.

Our comment may suitably take the form of examining each section of the triple basis in turn. With regard to agnosticism, we are inclined to wish that Prof. Huxley had avoided the word. It conveys the impression that those who use it doubt whether any large measure of trustworthy truth is available where ultimate questions are concerned. If the historically untenable idea of a supernaturally revealed dogmatic system is to be replaced, some new theory of the attainment of religious knowledge will have to be provided. We fear that Prof. Huxley does not clearly envisage the nature of the problem with which those who believe in religion without believing in 'revelation' are faced. That problem is the provision of an altogether new theory of revelation.

With regard to evolution, the introduction of this conception into our thinking is in reality the only sure safeguard against dogmatism, and makes anything like systematic agnosticism unnecessary. Evolutionary ways of thinking have imported some measure of relativism into our ideas without endangering the indispensable notion of objective truth. They have banished dogmatism without introducing scepticism. As Prof. Huxley puts it:

"Thought evolves equally with life. Religious systems which were inevitable products of humanity's childhood or of his adolescent thinking . . . are not for that reason final. Ideas which in their time and season meant immense advance . . . may actually become harmful when circumstances alter and the old ideas are found to be hindering the progress of new and better ideas."

Then, with regard to psychology, the last part of the threefold basis. We owe a great debt of gratitude to Prof. Huxley for having included an autobiographical chapter in his book. It is to be feared that some men of science have written of religion while having very little first-hand experience to guide their speculations. This is not the case with Prof. Huxley, who seems to have been through religious experiences which only differ from the normal by being more intense. His experience seems to have taken the form of nature-mysticism united with fervent moral idealism, but apparently unconnected with the dogmas of 'revealed' religion, from the teaching of which his childhood had been free. (It is to be noted, however, that he was brought up in an atmosphere of vigorous moral earnestness, quite different in character from much of the frivolous irreligion of the present day.)

In view of all this, it is a little of a disappointment to find Prof. Huxley inclined to surrender his experience to the inadequate and rather shallow interpretations of the psychologist, who, to be sure, is too much with us to-day. He writes:

"They [the religious experiences] and my reading also convinced me that the revelation of the mystic vision is revelation only in a psychological sense, not literally. There need be no supernatural

being or force making the revelation; nor is the revelation one of an external reality."

This last sentence, however, seems to be quite unhelpful dogmatism. It would have been more profitable, and more scientific, to inquire what kind of truth mystical insight may be expected to supply us with, whether similar in kind to that supplied by æsthetic or moral insight, or otherwise. In point of fact, some philosophers, quite innocent of theological bias and without the qualification of having enjoyed Prof. Huxley's remarkable religious experience, are inclined to attribute considerable significance to such phenomena. Mr. C. D. Broad, for example, though confessedly almost devoid himself of such experiences, has expressed his belief "that they are probably of extreme importance in any theoretical interpretation of the world."

It is a curious fact that about the real bone of contention between religion and science at the present time, that is, miracle, Prof. Huxley says scarcely anything. This is at present the crux. It is as it were a correlative to revelation; as this is the supernatural in the sphere of knowledge, so the miracle is the supernatural in the sphere of action. In what sense, if any, we can hold to either of these conceptions needs thinking out very carefully.

(3) Dr. Hector Macpherson, in his book "The Church and Science," does devote a chapter to the miraculous. He points out that the reformers took over Aquinas's conception of miracle, which at least had the advantage of being clear and definite; it was an event having its cause outside Nature. The difficulty, of course, is that until you know the whole of Nature, you cannot tell what lies outside Nature. No man of science will consent to adopt this method of explanation, as it stultifies his methods entirely. Dr. Macpherson quotes extensively from Mr. J. M. Thompson's "Miracles in the New Testament," a book which made a considerable stir when it appeared in 1911. Mr. Thompson's view was that the doctrine of the Incarnation can stand quite independently of miracles; but as he was inhibited by the Bishop of Winchester at the time, it does not look as if his views were accepted by the ecclesiastical authorities. As a matter of fact, the book was a careful piece of textual and literary criticism of the New Testament documents concerned, and its reception showed that orthodox theology had not yet come to terms with the critical study of literary sources. In other words, the religion and science conflict has settled down at present to a controversy between scientific history and theological history.

J. C. HARDWICK.

Cultures and Migration.

Psychology and Ethnology. By Dr. W. H. R. Rivers. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxviii + 324. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1926.) 15*s.* net.

THIS volume is one of a series entitled "The International Library of Psychology, Philosophy, and Scientific Method." Rivers was above all a master of method, and had he lived to write a book on method in the historical investigation of human cultures, he would have added to the already great debt anthropologists owe him. The present work is a collection of lectures and essays, dealing mainly with the constant theme of the historical school of anthropology, the unity of culture. The greater number were delivered to somewhat mixed audiences, hence there comes about an almost wearisome reiteration of the hypotheses, and perhaps—apart from pan-Egyptianism—some over-emphasis of the differences between the views put forth by the historical or diffusionist school and by other anthropologists. The chapters have not been arranged chronologically to show Rivers's contribution to method—indeed, his first and by far his most important contribution, "A Genealogical Method of Collecting Social and Vital Statistics" (*Jour. Roy. Anthrop. Inst.*, vol. 30, 1900), has been omitted—but come under a few selected headings.

The reader who bears with these disadvantages will be rewarded, not with the proof or disproof of the theories of the extreme diffusionists, but by the discovery of some of the principles and results that Rivers worked out when studying the contacts of peoples in Melanesia, where he carried out the plan he had previously elaborated for obtaining exact information; that is to say, he used the genealogical method with the study of kinship as the basis of investigation. When he examined his material he came to certain conclusions which may be looked upon as his chief methodological results, in this review arranged and to a limited extent discussed under numerical headings:

(1) That social structure, the framework of society, is fundamentally important, and not easily changed except as the result of the *intimate blendings of peoples* or of the most profound political changes, and for that reason furnishes the firmest foundation on which to base the process of analysis of *culture*. The relative permanence of

the social structure is so great that its course of development may furnish a guide to the action in order of time of the different elements into which it is possible to analyse a given culture complex (pp. 135-8). These two sentences are condensed from "The Ethnological Analysis of Culture," but the italics are my own.

Yet, if I understand aright the general trend of these essays, Rivers later accepted a more extreme diffusionist view, namely, that cultural changes were introduced by the carrying about the world by small bands of foreigners of definite elements, independently of any general cultural blending. On the other hand, a collection of essays offers no such continuous structure that it is possible to be certain that Rivers had entirely realised the full significance of the acceptance of this proposition, which logically would lead to the rejection of so much of his previous work. Such wholesale modification of viewpoint seems scarcely likely, for Prof. Elliot Smith himself has said in the preface to "Social Organisation," published in 1924: "On his own admission his work on social organisation was his greatest achievement in his chosen field of investigation," so we may perhaps regard "blending" as not consciously jettisoned, though in many instances Rivers no doubt did accept the free transmission of foreign elements. As an example of the kind of difficulty referred to, it is sufficient to compare the views on the dual organisation put forward by Rivers on one hand and by Prof. Elliot Smith and Mr. Perry on the other, who regard the dual organisation of society as one of the elements of culture that arose in Egypt and was carried about the world (Elliot Smith, "Encyclopædia Britannica," vol. 30, article "Anthropology"; Perry, Appendix 3 to Rivers's "Social Organisation"). These views may be contrasted with the treatment of dual organisation in the "History of Melanesian Society," for example, vol. 2, p. 250.

(2) The second principle is that involved in the disappearance of useful arts; this is a feature of the degeneration of culture which plays so large a part in the scheme, and is one which had long called for examination. Here we may direct attention to one aspect of the controversy which might be overlooked by those who are only interested in the proof or rejection of the general idea, namely, that it is the 'common sense' view that man is guided by reason which is here refuted. In the examination of the causes of the disappearance of the canoe from the Torres Islands and Mangareva, Rivers was led to reject material and social factors as insufficient in themselves, and he saw in the loss of the magical and religious rites accompanying the craft the loss of the craft itself. He does not, however, suggest any reason for the loss of the magic:

"Quite as striking as the loss of useful arts is the extraordinary persistence of elements of culture which seem to us wholly useless . . . this . . . combines . . . to make us beware of judging human culture by purely utilitarian standards" (p. 208). One of the difficulties here is to recognise what to the savage is a purely utilitarian standard.

(3) The extent of the influence of one people upon another depends upon the difference in the level of their cultures. A very small number of immigrants of a sufficiently high culture can have a relatively enormous influence on a low culture. This is the principle relied upon for the spread of the megalithic culture in the essay entitled "Contact of Peoples," and comparison is made of European influence on peoples of the lower cultures on one hand and on those of India and China on the other.

(4) The motive for migrations determines their distribution, which might otherwise appear fortuitous. Rivers accepted Mr. Perry's theory, that the motive was the search for wealth or life-giving substances: "The force was attractive rather than propulsive, viz. the love of wealth, which is still the most potent factor in immigration" (p. 171). This was probably not intended as a principle to be taken without other subsidiary factors, for though the love of wealth may always be present, immigration is periodic. Moreover, when particular instances are examined the thesis is likely to break down, as in the example afforded by the recent discussion on pearls in *Man*; again, it is doubtful whether the love of wealth had any considerable influence on the first great spread of Islam, though trading and slave raiding undoubtedly assisted or even led to later movements.

(5) Ancient beliefs tend to be preserved with greatest fidelity not near their old home but in remote spots, among people of a simple mentality. This conclusion was drawn after the construction of a hypothetical scheme to account for belief in 'soul-substance' in Melanesia (including New Guinea), as well as for the burial customs of San Cristoval in the Solomon Islands. The reason adduced is the simple mentality of the people, which leads them to "accept without any great modification beliefs which take their fancy, while the absence or scarcity of later external influence

prevents the modification, or even obliteration of beliefs, which are always liable to occur among more sophisticated peoples and in regions more open to the play of external influence" (p. 118). This principle, the parallel to that of the distribution of living animal forms from a geological centre, seems to have been elaborated independently. With all necessary reserve, the reviewer would place on record his belief that of late anthropologists have tended to underestimate the fluidity of native custom and its capacity, nay its tendency, to modification within its own sphere of activity without foreign stimulus.

(6) "Wherever we find diversity of funeral rites, we may safely conclude that there has been diversity of culture" (p. 163). This conclusion is drawn from the general observation that rites, ideas, and beliefs concerning the dead are among the most sacred of human reactions, and held with the greatest conservatism. The diversity of funeral rites in Australia is one of the main causes that led Rivers to suspect the complexity of Australian culture.

Handled with caution, all of the above are useful principles, but the need for caution cannot be overrated. For though the diffusionist school that Rivers upholds in this volume is sometimes called the historical school, its relation to history is precarious and depends on a number of bold assumptions. The existence of the Egyptian culture is an historic fact; its connexion with the megalithic culture a courageous deduction with which archæologists in general disagree. Moreover, the migrations from Egypt with which the diffusionists deal are all ignored by historic records, nor has a single specimen, not even a potsherd, of Egyptian or Near Eastern manufacture been found in those localities supposed to have been most subject to Egyptian influence. The assumed motives of the migrations are yet bolder. Present customs are explained in the light of hypothetical migrations, and the megalithic culture itself explained by comparison with modern custom. The danger of the vicious circle is obvious, yet this statement should not be taken to imply that we need be satisfied with the methods of anthropology before the florescence of the diffusionists. No doubt there is much to be learnt by the careful application of Rivers's principles to some known historic movement, as, for example, the spread of Islam. The different phases in its extension could be studied; its conquests and its forms of peaceful penetration contrasted, and the varying results examined. Such an examination might even justify some of the more far-reaching speculations of the school. Above all, such studies, starting from definite historical facts, and continually checked by these, should throw light on the formation of new culture complexes, and thus to some degree act as a test of the validity of the hypothetical schemes put forward by the diffusionist school.

C. G. SELIGMAN.

Two Fundamental Problems in Physical Chemistry.

Physico-Chemical Metamorphosis and some Problems in Piezochemistry. By Ernst Cohen. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University.) Pp. vi + 190. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 2.50 dollars.

PROF. ERNST COHEN of Utrecht went to Cornell University early in 1926 as the first holder of a non-resident lectureship in chemistry, supported by an endowment given for this purpose by Mr. G. F. Baker. His introductory lecture, under the title "Qua vadimus?" has already been circulated to many workers who receive reprints from the van 't Hoff Laboratory at Utrecht; but it now appears as the precursor of ten lectures on "Physico-Chemical Metamorphosis" and eleven lectures on "Some Problems in Piezochemistry."

The first series of lectures deals with the transformations (and especially with the suspended transformations) of tin, antimony, cadmium, thallous picrate, cadmium iodide, and ammonium nitrate. In all these cases the author provides evidence of the difficulty of securing the complete transformation of a polymorphic solid into one of its possible forms, and the risk that, if sufficient precautions are not taken, the physical data recorded will be those of a mixture of the various forms. This risk must be admitted, but not to the extent of producing a pessimistic outlook, since inconstant results generally provide an efficient danger-signal when a condition of complete equilibrium is not being attained in any given series of experiments. The cases cited, which include those of 'tin pest' and 'explosive antimony,' are, however, of a very interesting character, and include some of the most dramatic results of the author's own researches.

The second series of lectures is chiefly remarkable for the skilful handling which it discloses of the difficult problems encountered in carrying out the common operations of physical chemistry *under a pressure of* 1500 *atmospheres*. Under these

conditions, determinations of reaction-velocity, solubility, electromotive force, electrochemical equivalent, velocity of diffusion and viscosity, all call for the invention of appropriate apparatus, embodied in workmanlike designs, for making measurements of a high order of accuracy, whilst paying due regard to the possible effects of contamination by the fluid through which the pressure is transmitted to the system under investigation. It is therefore not an adverse criticism to say that more interest and instruction is to be found in reading *how* the experiments were made, than in nothing the character of the numerical results that were recorded. It is, indeed, almost a disappointment to read of the unfailing regularity with which the predictions of thermodynamics were fulfilled, since a few violent exceptions would have added an element of sport to what is now an almost monotonous record of difficulties surmounted and goals attained.

Those who know Prof. Cohen's linguistic and literary skill, and in particular his perfect mastery of English, together with the winsomeness of his appeal to his hearers, can paint a vivid picture of the attractiveness of the course of lectures to those who had the privilege of listening to them. The printed record will, however, be read with pleasure by a much wider circle of interested students and teachers, since it provides in a convenient and attractive form the equivalent of two monographs on subjects of wide general interest. T. M. L.

Our Bookshelf.

The Making of a Chemical: a Guide to Works Practice. By E. I. Lewis and Geo. King. Pp. 288. (London: Ernest Benn, Ltd., 1927.) 12*s.* 6*d.* net.

It must be something like twenty years since Mr. E. I. Lewis achieved fame as the author of an inorganic chemistry, which differed widely in character from most of the text-books that had been written previously. Mr. Lewis's book was specially designed for the needs of boys coming over from the classical side, who did not need to acquire a professional knowledge of the subject, but were expected to secure some measure of scientific culture from its study. His book proved, however, to be of wider value, in that its broad and philosophic treatment made it a suitable revision book for many students who had taken an elementary course, but without acquiring the fuller knowledge of the foundations of his faith, which one looks for in a university worker.

The schoolmaster has now become an industrialist, but without losing either his literary skill or his desire to teach the rising generation. He has, therefore, in collaboration with a colleague, written a book on "The Making of a Chemical," in which he gives much excellent advice to the student who is about to enter, and hopes to find a career in, chemical industry. His advice is so good that, if it were all put into practice, the product would be almost too perfect to be useful; it has certainly had the effect of leaving the reviewer with a sense of his own unworthiness to undertake so high and holy a vocation, and to marvel at the lofty heights to which the authors of such a book must themselves have attained.

On the other hand, if the reader is prepared to leave good advice to suffer its usual fate, he will find that the book contains a very useful sketch of the fundamental problems of chemical preparation when carried out on a large industrial scale, and a very readable summary of the typical solutions of these problems. Even more useful, perhaps, is the frequent reference to technical books, since the academic student, who knows how to track down original references with the help of Beilstein and the British Abstracts, may very easily be floored by the problem of finding out where to go for a trustworthy review of the best current practice in some branch of chemical engineering. The authors, one may suppose, have themselves tested and vindicated the usefulness of the books which they cite, and they will have rendered a real service to the young industrial chemist if they are able to guide him in the early stages of building up a technical library of his own.

Sex and Repression in Savage Society. By Bronislaw Malinowski. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xv + 285. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1927.) 10*s.* 6*d.* net.

In this volume Prof. Malinowski restates his position in relation to the Freudian doctrine of the Œdipus complex, showing how that theory of father-and-son antagonism and a mother-and-son attraction based upon a sexual impulse, having been formulated in relation to a patrilineal society, breaks down when applied to the behaviour of peoples organised on matrilineal lines. He then passes on to the consideration of the nature of the influence of the family complex on the formation of myth, legend, and fairy tale, on customs, form of social organisation, and achievements of material culture, and finally passes to what is the most important contribution of his book to this subject, the consideration of the origins of culture, where he finds himself on the borderland between the animal and the human.

On the view that the instincts are plastic, and can be and are moulded by cultural influence, what the Freudians regard as fundamental, the manifestation of the sex instinct and its repression, become incidental. When it appears it is a maladjustment. Prof. Malinowski's conclusion, therefore, is that the building up of the sentiments and the maladjustments which this may entail depend largely upon the sociological mechanism working in a given society. The main aspects of this mechanism are the regulation of infantile

sexuality, the incest taboos, exogamy, the apportionment of authority, and the type of household organisation. This contribution by Prof. Malinowski to the discussion of Freudian doctrines is one of considerable importance, based as it is upon material actually gathered in the field, but it will be a matter for regret if its polemical character in part obscures the fact that it is one of the author's most original and suggestive contributions to anthropological theory.

Beiträge zur Kenntnis der Verbänderung und einiger verwandter teratologischer Erscheinungen. Von Dr. Const. C. Georgescu. (Botanische Abhandlungen, herausgegeben von Prof. K. Goebel, Heft 11.) Pp. 120. (Jena: Gustav Fischer, 1927.) 6 gold marks.

THIS little work on fasciation contains some experimental and observational results and an incomplete bibliography of the subject. The author points out that fasciation may occur as a modification caused by excess nutrition, attacks of insects, etc., but that it is more commonly a mutation. *Celosia cristata*, the cockscomb of gardens, is an example of such a species. Its origin is unknown, although it is now cultivated all over the world, but it was known to Pliny. In culture solutions lacking particular salts, no effect was produced, except that the absence of calcium prevented flowering. Races of Celosia differed in the degree or amount of fasciation, and bad conditions reduced the number which showed it. Experiments were also made with *Sambucus nigra*.

Fasciation may occur in stems, roots, flowers, fruits, or even stigmas. The author classifies fasciations as dorsiventral or bilateral, which can be anatomically distinguished. Two types of shoots are also distinguished, in one of which there is flattening throughout, while in the other only the tips of the branches are flattened. Fasciation results in abnormal phyllotaxy, and a morphological study is made of this condition, especially in Sambucus and Celosia. R. R. G.

Balancing the Farm Output: a Statement of the Present Deplorable Conditions of Farming; its Causes and Suggested Remedies. By Dr. W. J. Spillman. (Farm and Garden Library.) Pp. 126 + 10 plates. (New York: The Orange Judd Publishing Co., Inc.; London: Kegan Paul and Co., Ltd., 1927.) 1.25 dollars.

THE title of this little book indicates that Britain is not the only country in which farming is in a deplorable condition. The cause is the same; current prices run below costs of production. Many remedies have been suggested, and it is surprising to learn that so many countries have adopted various schemes of what our author terms 'valorisation,' that is, an artificial raising of home prices by State action. In regard to all these schemes the author prophesies disaster. In their place he would substitute a scheme of which it is sufficient to say here that it predicates a degree of State interference with private business which—if endurable in an autocratically governed country like the U.S.A.—would not be tolerated in Great Britain. The book, however, is valuable as a reasoned summary of schemes for remedying an undoubtedly serious state of affairs. For ourselves, we would rather pin our faith on the march of knowledge: if practice is outworn, our only hope is science and, again, more science.

Geologisches Praktikum. Von Prof. Dr. Rudolf Sokol. (Sammlung naturwissenschaftliche Praktika, Band 13.) Pp. viii + 248. (Berlin: Gebrüder Borntraeger, 1927.) 14·50 gold marks.

PROF. SOKOL completed this book in December of last year, but unfortunately he did not live to see its publication; two months later he passed away. The obituary notice which has been added to his book pays high tribute to his great reputation as a teacher, and the book itself calls for equal praise. After insisting that a geological training demands a preliminary acquaintance with many other branches of scientific knowledge, the subject of map-reading, topographical and geological, is introduced. Instruments are next passed in review, and this section includes an account of the use of the Eötvös balance. Materials are treated at some length; their collection, preparation, and investigation; their nature and distribution and relative ages. Structural geology occupies a third of the book, and the section dealing with faults, their measurement and description, is particularly valuable. Suggestions are given for making and noting observations in the field; for making maps; and for writing up reports. The concluding sections deal briefly with materials of economic importance. A short bibliography is appended, but this is unsatisfactory, since it contains no references to British works. The book is strongly bound and effectively illustrated.

The Physiography of the Region of Chicago. By F. M. Fryxell. Prepared by the University of Chicago Local Community Research Committee, and the Chicago Commonwealth Club, for the Committee on General Surveys of the Chicago Regional Planning Association. Pp. viii + 55. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1927.) 12*s*. 6*d*. net.

THIS very careful study of the physical geography of the Chicago region is a model of the kind of foundation that is desirable for regional survey work, and as such it is likely to be of special value to the many British workers and teachers who are similarly interested in their own neighbourhoods. It is also of more general interest in containing many excellent diagrams and a series of folded maps showing relief, drainage, glaciation, and soils. The topics discussed include the great industrial area of the lake plain; the surrounding recreational areas; the pass to the Mississippi valley; the continental divide; the shore line of Lake Michigan; the buried landscape of the bedrock; the agricultural areas and soils; and the geological resources. A large base map specially prepared under the direction of Prof. J. P. Goode folds into a pocket on the back cover.

Letters to the Editor.

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

The Mathematics of Intelligence.

IT has been said by Kant that a science is genuinely scientific in so far as it involves mathematics; and interesting light is thrown on this dictum by considering it in reference to the various attempts that have been made to introduce mathematics into psychology. First came the grandiose effort of the Herbartian to depict mathematically the interaction of ideas. This failed for total lack of experimental support. Then followed the great and very successful attempt of Weber and Fechner to measure sensory discrimination. Much more recently, there has been an invocation of mathematics for the purpose of analysing mental ability. As this last attempt is now very much perturbing psychologists all over the world, let us consider it in a little more detail.

In the year 1904, on the basis of a mathematical theorem coupled with some actual observation, the doctrine was advanced that the measure of any individual in any ability could be divided into two factors; the one was common to all the abilities concerned; whereas the other was specific to the one ability alone. These two factors were designated by the letters g and s; and the extremely important corollary was drawn that, by averaging together many dissimilar mental performances, the influence of the s's would tend to cancel out, leaving an approximate measure of the pure g.

This doctrine was very unexpected, and gave rise to an acute controversy which has continued ever since. On the mathematical side, the objections raised have one by one been either refuted as pointless, or else met by further developments. On the side of observation, the scope has been continually broadened. Originally, the work had been limited to a single experimenter dealing with little more than 100 individuals, all of whom were young boys. But already in 1912 the range had been extended to 14 experimenters treating 1463 boys and girls, men and women, sane and insane. At the present day, this number of experimenters has certainly been quadrupled, whilst the number of individuals has grown to many scores of thousands. Finally, the attempt was made by me in a book entitled "The Abilities of Man" (Macmillan, 1927) to bring all this work into one systematic whole. The interpretation of g found to account best for all the observed facts was to conceive it as measuring some general 'energy' responsible for all the activities of the mind. The s's, on the other hand, were taken to be the various 'engines' into any of which the energy could alternatively be directed.

In addition to the g which thus measured the quantity of the mental energy, there was also determined a value p which measured the degree of the 'inertia' of this energy; and furthermore, an o which measured the degree that the supply of the energy tended to oscillate. These three measures conjointly were said to furnish the cardinal features distinguishing the abilities of one individual from those of another. The evolution of the doctrine went further still, carrying it far beyond the whole sphere of psychology known as that of individual differences. For during the time that the facts belonging to this sphere were being investigated, those appertaining to 'general psychology' were being treated from a fundamentally novel viewpoint (that of the doctrine known as 'noegenesis'). The surprising result was that these two spheres, hitherto kept by psychology in disastrous divorce from one another, now fitted as hand and glove. Finally, both these spheres of cognition, that of individual differences and that of general psychology, have in the continued development of the doctrine of g and s become organically united with that other great domain of the mind which is not cognitive but conative; it does not deal with knowing, but with striving and deciding. To the g and the s's of the energy and the engines, there has now been added a w, which brings all these into action, playing thus the part of the 'engineer.' Accordingly, the entire movement having as its core the concept of g has constituted a great endeavour to supply psychology at last with a unified, complete, and genuinely scientific foundation.

A review of "The Abilities of Man" was published in NATURE of Aug. 6, the reviewer adopting an extreme attitude in the now rapidly dwindling opposition party. For my part, I welcome this review in so far as it expresses the chief lines that may still be taken up against the book. But I cannot help regretting that it should present an entirely incorrect picture of what is given in the book itself. In the first place, there is the grave default that the foregoing immense scope of the work done—just the scope that the book expressly set out to narrate—is not even hinted to the reader of the review; and then this, on the positive side, is throughout strangely permeated with vital misapprehensions, as will be seen by taking each of its points in turn.

1. The beginning of it is a general complaint that the statements in the book cannot be adequately verified for lack of sufficient arithmetical data and mathematical demonstrations. But it must be replied that data are really furnished in very great quantity, so that any one can check the arithmetic as much as he pleases; while all the chief mathematical demonstrations are given fully in the appendix.

2. Next, the objection is raised that the book criticises the definitions of 'intelligence' given by other people, but fails to supply one itself. Really, the tenor of the book was to suspend usage of the highly equivocal word 'intelligence' and to show unequivocally what mental powers actually exist. Then, indications were furnished as to which of these powers might be entitled intelligence most reasonably; but the suggestion was made of abolishing the word altogether.

3. After this, the reviewer commits himself to a very serious statement. The book, he asserts, 'hypothecates' that the measurement of an ability is a function of two factors and then proceeds to replace this general functional relation by a purely linear one. In answer, he must be referred to the actual mathematical demonstration (appendix iii-v). This really contains no such hypothesis, no such replacement, nor anything like them; but instead, a full proof that *when* the correlations are what has been called 'hierarchical,' *then* the measurements can be expressed as linear functions of the two factors. As much may be said of the earlier proof supplied by Garnett.

4. Neither proof implies even Taylor's theorem *directly*. Such an implication is only *indirect* and occurs only to the extent that this theorem may underlie the significance of the whole theory of correlation and even of 'normal' frequency. In the book I ventured to throw out the suggestion that the

theorem may be thus implicated in the theory of correlation. But I do not press this matter for the present. I only mention it here as I wish to admit frankly that the book did not make this distinction between direct assumption and indirect implication nearly clear enough.

5. The reviewer's next point is that a certain important quantity called the 'tetrad difference' was assumed by the book to have a normal frequency, whereas, he says, the data in the book itself prove that the distribution is not normal. In truth, the book never made any such assumption; instead, it *showed graphically* that the frequency is normal with *good approximation*.

6. He then objects that the mean tetrad difference had been made by me zero artificially. In truth, the mean of all the tetrad differences from any set of variables is zero *necessarily*.

7. Then the reviewer lays down that the only real test provided of the agreement between theory and observation is a comparison of the probable error of the tetrad differences with their observed median value; and this test he considers not to have been passed with manifest success, since (in the case he picks out) the probable error was 0·061 and the observed median 0·062 (or, according to him, 0·060 and 0·058 respectively). The reply must be that such two values do manifestly 'fit' each other very well indeed. In last resource, all evidence of good fit between theory and observation consists in thus simply juxtaposing the two values and seeing whether they are nearly equal. Certainly not often is the result more favourable than the above one.

8. In truth, however, this is by no means the only real test possible or provided. In statistics the probable error is compared, not only with the median of the observed values, but also with each of these values separately. This is what had been done throughout the book in treating the entire mass of available data published on the subject by the multitudinous investigators (including those belonging to the opposition party itself). The result was to show that whenever any tetrad difference did become excessive, then there were always good psychological grounds for it being so; the circumstances of the case were such as to require by theory that this particular tetrad difference should *not* be zero.

9. The reviewer closes by remarking that a better way to approach the problem would be to consider that, if we could assume the probable errors of the different tetrad differences to be mutually independent, then "We should . . . conclude that the new . . . theory, so far from being in 'striking agreement' with observation, signally failed." To this the answer is that, since any such assumption of independence is obviously quite wrong, the advantage of this new way of approach —or even the point of suggesting that then the theory would fail—is not evident.

Let us, however, now consider how far the present occasion can be utilised for converting mere wrangle into scientific progress. The cardinal points (3) and (6) are matters of pure mathematics; they therefore can and should be definitely settled. Unless, then, the reviewer is convinced by the foregoing remarks, I suggest that an impartial committee be appointed to adjudicate upon these two points and to report in this journal. As for the machinery of appointment, perhaps it could be done by a joint meeting of representatives of the Mathematical and Psychological Sections of the British Association. Points (1), (2), and (5) are misapprehensions which a closer study of the book ought easily to remove. But should the reviewer, after having heard my own account of what I wrote and meant, still insist that his version is more correct, then these points too might be submitted to the committee. As for points (7) and (9), these, I hope, are already sufficiently obvious. On the other hand, point (8), involving as it does every part of the book and the whole of cognitive psychology, does not appear to be capable of summary settlement. Since here the crux is far more psychological than mathematical, the issue must be left to the eventual consensus of the general body of psychologists.

C. SPEARMAN.

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W.2.

THE review in NATURE of Prof. Spearman's book stated precisely what was possible in a critique which must not be of inordinate length. The review of the work took what its author in his present communication considers the kernel of his researches and of his recent book, namely, the hypothetical g and s, and considered whether Prof. Spearman was justified in making such sweeping claims for the hypothesis of a general and specific factors. The reviewer held, and still holds, that whether that hypothesis be verifiable or not, the data hitherto cited in favour of it are far from demonstrating its truth. In reply to Prof. Spearman's numbered statements the reviewer wishes to make the following counter statements.

(1) The general complaint that the actual data by which the conclusions in the book can be tested are not provided is correct. It took weeks of work to reproduce the frequency data for tetrads on which the chief arguments in chap. x. are based. When this was done the extent of the agreement was found to be not such as appears in the book itself.

(2) The reviewer's opinion that it is easier to criticise definitions than to provide them will be amply illustrated—at any rate to a physicist—by a study of chaps. ix. and xxiii. of "The Abilities of Man."

(3) and (4) The reviewer can only repeat his assertion that Prof. Spearman has assumed that the functional relation is a purely linear one. The direct appeal to the lowest terms of a Taylor's series is made on p. v, and an indirect appeal to lineanity in pp. iii-v of the Appendix to which Prof. Spearman now refers. The statement that Taylor's theorem underlies the *whole* theory of correlation is incorrect.

(5) On p. 146 Prof. Spearman has the following words, beneath a diagram showing a normal frequency curve superposed on a series of rectangles: "This time the two distributions, *curve* and rectangles, far from being totally discrepant as before, display instead one of the most striking agreements between *theory* and observation ever recorded in psychology" (Reviewer's italics). The author's words clearly denote that the curve corresponds to theory and the rectangles to observation. If they do not, what is the 'theory' which so strikingly corresponds to observation? It cannot be the two numbers given under the diagram, for one of them depends again on the normal curve.

If the frequency be *not* a normal curve but a curve which really depends on the individual series of tetrads, what is the meaning of talking about 'discrepancy' between other tetrad distributions and the normal curve? A 'discrepancy' can only exist if a theory be known, and if Prof. Spearman's theory be not that of the normal curve, he has no measure of discrepancy. What is his 'theory'?

(6) The reviewer did not object to Prof. Spearman

making his mean of tetrads zero, by taking each one first positive and then negative, but what he pointed out was that having done this and got a symmetrical curve, Prof. Spearman in every case was depending upon the value of a *single* constant of this artificially symmetrical distribution to test the accordance of theory and observation. No frequency distribution is defined by a single constant.

(7) This should read of course the "only real test provided" by Prof. Spearman; there are many other possible tests, so soon as we know definitely what his theory of tetrad distribution really is. The terms 'probable error' and 'observed median' appeal directly to the theory of a *normal* distribution. Values such as 0·060 and 0·058 may or may not be in agreement. It depends entirely on what the probable error of their determination may be. Read in hectometres, the average statures of Englishmen and Frenchmen are 0·017 and 0·016 respectively. Do these "manifestly 'fit' each other very well indeed"? Prof. Spearman writes: "In last resource, all evidence of good fit between theory and observation consists in thus simply juxtaposing the two values and seeing whether they are nearly equal. Certainly not often is the result more favourable than the above one." The reviewer ventures to think this remark is erroneous. The true statistical theory consists (i) in deducing a correct arithmetical result from the data, (ii) in propounding a correct and comprehensive theory, and (iii) in testing by the theory of errors whether the deviation between observation and theory is or is not probable on the basis of random sampling. In all three points, in the opinion of his reviewer, Prof. Spearman has failed. His arithmetic is not always, but is often incorrect—his theory of what the variation of the tetrad distribution should be is incorrect—and he never concerns himself with the probable error of the difference between his theory and his observations. In the case of the statures cited above, the probable error of the difference is of the order 0·0002, and this is precisely what occurs in a number of Prof. Spearman's cases—three (and sometimes two !) significant figures are not adequate to reach the probable error of the difference, even if that difference were based on a satisfactory mathematical theory.

(9) The answer here is a perfectly definite one. Prof. Spearman looks at two numbers or at a graph and asserts, apparently by mere inspection, that they are in 'good approximation.' The reviewer holds that no such inspection is of any real scientific value; a numerical test of some kind to measure the extent of this agreement must be applied. Where in mere inspection does Prof. Spearman introduce the fact that his tetrads are correlated? How does he allow for it in running his eye over the graph? Is he not judging, as we suspect he must, that his curve fits well his rectangles, *however those rectangles have arisen*? To test this we supposed those rectangles not to have arisen from tetrads, and we find the fit for such a system of frequency is *bad*, not good. How does Prof. Spearman, by aid of a special *s* factor, determine that owing to correlation the eye alone can judge between the two cases and assert that the fit of curve and rectangles is good for tetrads, but would be bad for a series of intelligence quotients on different individuals?

Are we prevented from applying a test of goodness of fit to measurements on a colony of statoblasts because there exists a high degree of hereditary correlation between its individuals? The reviewer wrote in his notice of "The Abilities of Man" that the pages of NATURE could not provide adequate space for a full mathematical and statistical criticism of Prof. Spearman's hypothesis. The first part of such a criticism is now at press, and will be published shortly.

THE REVIEWER.

[Prof. Spearman has left England for the United States and will not return until January next. He desires it to be known, however, that he proposes to pursue the conflicting statements in this correspondence by means of independent adjudication, as suggested in the concluding paragraph of his letter. —ED. NATURE.]

Possible Explanation of the Zodiacal Light.

THE nature or origin of the zodiacal light is regarded as more or less of a mystery. Some have thought that the phenomenon may indicate the existence of a diffused ring of small particles in equilibrium and in nature somewhat like those of Saturn's rings, though more scattered and existing in very small amount compared thereto. This hypothesis assumes a stability which it is difficult to accord to such a ring.

If we assume, however, that the coronal streamers from the sun, which apparently extend without limit of distance into space, are partly composed of or accompanied by fine particles propelled by the pressure of light, or even of fine solids from condensation of vapours arising from the solar atmosphere and expanding into a vacuum external thereto, we may form a hypothesis which seems to be consistent with the facts. The fine condensed particles would move into a vacuous space in substantially straight lines and would reach enormous distances from the solar body. As the spectrum lines of iron are prominent in solar light, it might be expected that in the space surrounding the sun fine particles of iron would constitute, in part, at least, those escaping streamers from the solar atmosphere. These particles would surround the earth and be extended in all directions therefrom.

If they be of the same or of similar nature to those which in my experiments are seen to line up in a magnetic field (the observations on the novel magneto-optical effect described in NATURE of June 23, 1921, p. 520), then the zodiacal light, which is seen best at places near the equator and at times of vernal and autumnal equinoxes, might be explained as follows: The magnetic field lines of the earth joining the north and south areas outside the earth would, at the equator, lie sensibly parallel to the earth's axis, but at a great height, on the average, above the surface of the earth. This is illustrated in the subjoined diagram (Fig. 1), which indicates the general trend of the earth's magnetic field (one side only) all around the earth in the space about it.

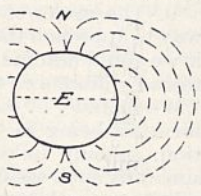

FIG. 1.

The dots in Fig. 2 do not represent floating particles, but are intended to show only that if one could look at a pole of the earth from a great distance and see a section through the equatorial plane, the lines of force of Fig. 1 might be indicated as dots in the equatorial plane. Now let the sun's rays be from below; it will be seen that they intersect the direction of the magnetic lines at nearly right angles. Now, further, let us by some means render visible in the polar beam the magnetic field about the earth; it will become apparent that it will be best seen by observers after twilight at night and before twilight in the morning—best at the time of the equinoxes and best in the tropical night. On the average, the observer placed at about *a* or *b* looking upward, will

be well placed for such observation, and the column of light will extend from *c* to *d* on the evening side, and from *e* to *f* on the morning side, or over an angle of about 60° altitude, more or less.

It may, therefore, appear as a plausible hypothesis that the luminous effect known as the zodiacal light or the *Gegenschein* may be of the same nature as that observed in the combination of magnetic field, light beam, and iron smoke from an arc, as described in 1921 in NATURE. If the zodiacal light is polarised in the same way as the light from the iron smoke is polarised, and undergoes the same variations by variations in the direction of viewing it, these circumstances might assist in identification.

There has been no opportunity to make any observations on this point. As the luminosity of the zodiacal light is low, although coming from a great depth of space around the earth, there would not need to exist, for producing the effect, more than an exceedingly small density in the iron particles concerned, a density perhaps millions of times less than in my original experiments on the magneto-optical effect. It has been shown also that the orientation which is the cause of increased luminosity in the light beam is producible by a very weak magnetic field. That the direction of viewing is transverse to that of the light beam, and that the magnetic field lines are transverse both to the directions of viewing and the light beam, are significant facts. More and varied observations and experiments are certainly warranted in this fascinating field [see NATURE of Oct. 22, p. 581].

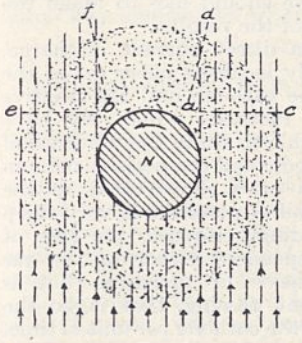

FIG. 2.

It will be seen that the hypothesis presented does not require any ring formation around the earth. It requires only that the general space surrounding the sun and planets contain an exceedingly small density of diffused iron particles, capable of being affected or oriented when in the magnetic field surrounding the earth, in which case they reflect the light of the sun to observers on the earth who are in favoured relation to them. Moreover, it may well be that the magnetism of the earth would tend to concentrate such iron particles, if any, in the space around it. If we have found a clue to the observed effects, further observations and investigations may confirm or oppose the hypothesis presented. ELIHU THOMSON.

Lynn, Mass.,
Sept. 1.

The Fields of Force in the Atmosphere of the Sun.

WHILE appreciating M. Deslandres's concluding paragraph of his letter in NATURE of Oct. 8, and reverting first to the problem of the equal spacing of magnetic disturbances, synchronous with corresponding spacing of solar longitudes, I am afraid my studies, to which he kindly alludes in *Comptes rendus* for Sept. 1926, came to a stop for reasons of the statistical material I up to then could work upon, failing me. Nor can I dispose of the required magnetic recording apparatus of the kind used at Meudon, and I was wholly confined to the Greenwich spot records, and to my own observations of eruptive phenomena either at the limb or on the disc. The first diagrammatic representation of this phenomenon which I made covers the minimum period, section from July 1913 to Dec. 31, 1914, and I found that my method for a maximum activity period resulted in great diagrammatic complication, not to say confusion. All the same, I felt from the first convinced that I was by no means dealing with an accidental phenomenon, and I am therefore very hopeful that the method used at Meudon will ultimately be completely successful.

M. Deslandres's proposition of an interior solar sphere, rotating like a solid, is very fascinating, and has, as an *a priori* assumption, many points of merit, but on the other hand also raises other difficulties. One of these is how to reconcile the equatorial acceleration with a deeper seated level, which rotates with equal angular speed in all latitudes. What becomes of the striking independence of activity for the two hemispheres, when for months at a stretch scarcely a spot, or a substantial prominence, appears in the north, or in the south? Certainly the observational fact remains, that pronounced activity may be confined for long periods within a very limited range of longitude and latitude; but even then great variations occur, which seem to preclude the idea of stationary eruptive, even intermittently eruptive, volcanoes. Diagrams I have made, covering many years, show these latitude changes for successive rotations perfectly plainly. At Stonyhurst they carry on a method of tabulation, which shows the changes in longitude *and* latitude on the same diagram. Can M. Deslandres offer a physical explanation of these changes, retaining the interior sphere which in his opinion gives birth to the solar spot and rotates as a solid would?

M. Deslandres refers to the difficulty of explaining the much lower temperature of solar spots. Nothing has occurred since I began to observe the sun thirty years ago, which upset my initial conviction that the evidence of the spectroscope in this respect is misleading. It should be remembered that when examining the sunspot spectrum, we allow combined light to pass into the instrument, not only that radiated by the spot-umbra and lower down, but also from great altitudes above the spot, all in the direct line of sight. Now my contention is that heaped up above the spot-umbra and its vicinity there are the gases of the uppermost and coolest layers of the sun's atmosphere, as in fact the photographic representations of the solar vortices intimate. These photographs receive their 'design' from the dark absorptively acting filaments at great altitude, converging and descending towards the spot in precisely the same way as the cloud trunk does in the terrestrial tornado, or in the waterspout phenomenon. The trunk of the solar tornado can be seen directly in many cases of active solar spots and gives rise to the 'claw' effect so well illustrated in W. C. D. Whetham's book, "The Recent Development of Physical Science," but the spectroscopic explanation is erroneous, as given on page 308. All this points directly to the screening from the terrestrial observer of the umbral level by a concentration of relatively cool gaseous masses above the spot. I have yet to see the observational, or physical, refutation of the late Mr. Wilson's temperature measurements of solar spots carried on at Daramona in 1895, which indicated the spot radiation at the limb to be relatively higher than when the spots were central. I submit that if M. Deslandres dismisses the theory of sunspots being cooler than their surroundings, at the level of the photosphere, he will find several problems easier of comprehension and explanation.

Nor do many phenomena in connexion with prominences admit of the dogma, that the sun is a truly gaseous body. Such types of eruptive prominences as the fascinating, clean-cut parabolic jets, are irreconcilable with a genuine gaseous state, and point

at best to a quasi-gaseous-cum-quasi-liquid interior condition.

The magnetic field seems to me to be induced mechanically by the whirling vortex, and I have seen on more than one occasion on the sun's limb an exact and complete representation of the converging luminous H_α filaments, as represented in Dr. Störmer's theoretical diagram, page 31, No. 109, of the Mount Wilson Contributions, these luminous lines strikingly representing the magnetic lines of force. The creation of a magnetic field about sunspots by the vortex appears to me a direct result of the violent temperature changes which are going on. Thus, for example, the conduction of hot steam into cool water means abrupt condensation and is accompanied by strong electric effects, particularly noticeable when the vessel containing the cool water is fairly well insulated. I have often wondered why this simple experiment has not been followed up and made use of industrially. Once electric effects are admitted in connexion with, and due to violent temperature changes, it does not appear very difficult to understand the possibility of attraction and repulsion effects also. ALBERT ALFRED BUSS.

22 Egerton Road,
Chorlton-cum-Hardy,
Oct. 12.

Flame and Combustion.

As a result of investigations on the effect of 'antiknock' compounds on the ignition of hydrocarbons, it was concluded that the combustion of hydrocarbons was autocatalytic and that the 'antiknocks' delayed oxidation by destroying the catalyst. It was further pointed out that these processes of catalysis were connected with the peroxidation of the fuel and of the antiknock, and that the course of the catalysis depended on the oxygen concentration (*Jour. Inst. Pet. Tech.*, pp. 244-280; 1927).

The effect of carbon disulphide on ether-air mixtures (cited by Dr. White in NATURE of Jan. 8, 1927), its effect also in raising the igniting temperature of petrol and in preventing 'knock' in engines in spite of its inflammability, can be ascribed to similar actions. Sulphur (particularly if combined with a reducing radical) can act as an 'antiknock' in the same manner as selenium, though to a less degree.

One is led to expect that the effect of water and of hydrogen on the combustion of carbon monoxide—air mixtures would be a similar case of catalysis, in which the peroxidation would be influenced by 'antiknock' compounds. The first experiments made to test this point were unsuccessful; Mr. Gates and I found that lead tetraethyl did not influence the combustion of carbon monoxide—hydrogen—air mixtures (except sometimes, it seemed, in explosions of a vibratory character). It was thought that the lead tetraethyl vapour probably did not have time to be decomposed before reaching the zone of combustion and could therefore not modify the flame speed. This surmise appears to be correct; Mr. Goodey and I have found that iron carbonyl, which decomposes at a lower temperature than lead tetraethyl, modifies the combustion of carbon monoxide—hydrogen—air mixtures very considerably.

The object of this letter is to direct attention to the importance of the study of the stages of combustion which precede inflammation—an importance to which Prof. Bone, from another point of view, has directed attention by his recent work on the explosion of methane—oxygen mixtures (*Proc. Roy. Soc.*, **114**, p. 442; 1927). The process which goes on in the body of the gas is catalytic and has a great influence on the subsequent ignition of the mixture, and is even important in the narrow region of heated gas immediately in front of an advancing flame. A. EGERTON.

Clarendon Laboratory,
Oxford.

IN conjunction with Mr. D. L. Hodge, for some time past I have been studying experimentally the combustion of $2CO + O_2$ (moist and dry) in a steady high tension direct current discharge, and the experiments have resulted in some new observations which seem to have an important bearing upon the function of steam in the combustion of carbonic oxide. We hope soon to communicate a detailed account of them to the Royal Society; meanwhile, in view of the general interest in the subject, we should like to make the following brief statement of the results.

In such a high tension direct current discharge, combustion may be wholly localised *either* (*a*) at the cathode *or* (*b*) in both the cathode and the positive column zones. By the methods which we have employed, we have been able to study the influence of moisture on both the cathodic and the positive column combustion. Our results have shown that in the cathode zone, where the fall of potential is very steep and the ionisation accordingly intense, the rate of combustion is quite independent either of the gas pressure or of the presence of moisture, but is proportional to the current passing, that is, to the number of ions arriving at the cathode per unit of time. In this region, the presence of moisture, so far from assisting combustion, slightly hinders it, owing to its diluent effect. Thus a sulphuric acid – dried $2CO + O_2$ mixture combined in this region at a rate about 15 per cent. faster than did the same mixture when saturated with water vapour at 17° C.

In the positive column region, however, where the potential gradient is slight as compared with that of the cathode zone, the presence of moisture greatly accelerated the combustion.

It would thus appear that, whereas moisture may accelerate combustion in a $2CO + O_2$ mixture in a region of comparatively weak ionisation, it has no influence, other than that of a diluent, in a region of sufficiently intense ionisation. Such results confirm the conclusions already drawn by Prof. Bone from his experiments, namely, that moisture is not essential to the combustion of carbonic oxide, and that (in cases where it accelerates the process) its rôle is electrical and not chemical. G. I. FINCH.

Department of Chemical Technology,
Imperial College of Science and Technology,
London, S.W.7.

IN commenting upon our previous letter in NATURE, Oct. 22, Prof. Armstrong stated that, in comparing the heats of combustion of carbonic oxide and hydrogen *in flames*, he had taken into account the heat of formation of water, not that of hydrone (steam), which can only mean that he supposes water (not steam) to be formed in flames. This being so, will he then kindly vouchsafe us an answer to the question put to him in our letter, namely: *Is there, indeed, any evidence that not 'hydrone' (steam) but something much more complex and 'hydronolic' (water) is formed in flames?* For we want to know what his answer is before deciding whether or not it would be safe for us to accept (as he suggests) the guidance of his 'imagination' whilst wearing our 'thinking caps.'

WILLIAM A. BONE.
D. T. A. TOWNEND.

Oct. 31.

Absorption of X-Rays in Various Elements.

RECENT investigations of the absorption of X-rays in different elements (aluminium, nickel, copper, silver, and platinum) and extended over a great region of wave-lengths (0·7 to 12 A.), using strictly monochromatic radiation, have led me to the following general laws :

1. The jump δ_K of the absorption coefficient on passing the K-absorption limit is :

$$\delta_K = E_K/E_{L_I},$$

where E_K and E_{L_I} are the energy-levels corresponding to the K- and L_I-levels respectively (see Siegbahn's "Spectroscopy of X-Rays," pp. 184-185). The total jumps at the L- and M-absorption limits are in the same way determined by the formulæ :

$$\delta_L = E_{L_I}/E_{M_I} \text{ and } \delta_M = E_{M_I}/E_{N_I}.$$

2. If the absorption is calculated per electron μ_ϵ instead of per mass unit μ/ρ ($\mu_\epsilon = \frac{\mu}{\rho} \cdot \frac{M}{N.L}$; M is the atomic weight of the absorbing element, N its atomic number, and L the Loschmidt-number), it can be shown from my own measurements and from earlier investigations that μ_ϵ is a function of the product $N\lambda$ for every branch of the absorption curve.

3. By using these two laws it is possible to give in a diagram, with μ_ϵ and $N\lambda$ as co-ordinates, *one single continuous curve for the absorption* at all wave-lengths and for all elements.

The new measurements and the results here mentioned will be given in a doctor's thesis (now in print) at the University of Upsala.

EDVIN JÖNSSON.

Physical Laboratory, Upsala (Sweden),
Sept. 15.

The Electric Arc in High Vacuum.

WITH reference to the interesting letter by S. Ratner on the electric arc in high vacuum, published in NATURE of Oct. 15, p. 548, this type of arc has been observed previously by me under conditions very similar to those used by the author (see *Phil. Mag.*, vol. 2, p. 796; 1926). I found that it could be excited in residual gases or in hydrogen at very low pressures, provided that an initial electrical discharge was sent between one of the iron electrodes and a third electrode.

The radiation emitted showed no trace of the iron lines, but gave a bright continuous spectrum together with lines and bands from the various gases present. There were really two types of arc—the ordinary arc, where the current rose in some cases above 10 amperes, and a brilliant glow during which a small current passed between the electrodes. Both these types could be excited at such low pressures that there was no trace of luminosity due to the electrical discharge.

Such an intermittent arc would form a convenient type of relay if the initial electrical discharge required were feeble, and if the arc would strike each time that this feeble discharge was sent through the tube. It was found, however, that these conditions were not fulfilled, the state of the electrode surface being an important factor.

The phenomenon is very interesting, and considering that the electrodes are cold, there seems to be no satisfactory explanation. F. H. NEWMAN.

University College, Exeter.

Psychological Dissociation as a Biological Process.

IN "Instinct and the Unconscious" the late W. H. R. Rivers suggested that the mechanisms of psychological dissociation familiar in human psychopathology have played a large part in the adjustment of the behaviour of animals during metamorphosis and in other changes of environment. The subject clearly had a great fascination for Rivers, and he reverted to it in a later paper ("Psychological Dissociation as a Biological Process," *Scientia*, vol. 35, p. 331; 1924). The purpose of this letter is to direct attention to the significance of a discovery which goes far to confirm these speculations.

In a recent paper on "Loss of Memory accompanying Metamorphosis in Amphilia" (*P.Z.S.*, pt. 1, p. 155; 1927), Major S. S. Flower records that salamander larvæ tamed to feed from the hand lost all their tameness at metamorphosis and had to be trained again *de novo*. In the main this abrupt disappearance of larval behaviour is just what Rivers predicted, though it appears to be correlated with the internal rather than the environmental changes of metamorphosis, the salamanders being apparently still partially aquatic when the change occurred.

It is much to be hoped that Major Flowers' most interesting observations will be extended and amplified. One would like to know, for example, if pre-metamorphic training facilitates or prejudices the acquirement of the behaviour after metamorphosis. Some quantitatively observable conditioned reflex would be invaluable in the investigation.

In conclusion, it may be emphasised that the abrupt change corresponds more to repression (= 'suppression' of Rivers) than to gradual growth out of a childish habit, and suggests that the former is, as Rivers suggested, a normal biological process not confined to human pathology.

G. EVELYN HUTCHINSON.

Dept. of Zoology,
University of the Witwatersrand,
Johannesburg, Oct. 12.

Geological Survey of Uganda.

AN unfortunate error has crept into the Annual Report of the Geological Survey of Uganda for the year 1926, whereby the reader is informed that Mr. A. D. Combe, of this Survey, is of opinion that there is a continuous succession through the Transvaal System into the Waterberg System in the Cape Province of South Africa. May I be permitted to make use of the columns of NATURE to correct this error? Perhaps readers of this journal who have copies of the report will kindly turn up page 32, delete line 34 and delete all of line 35 except the last word and the comma in front of it, and re-write thus :

"Mr. Combe suggests that in the Katanga Province there may be a continuous conformable succession through the equivalents of the Transvaal and Waterberg Systems without an unconformity, similar to the grand conformable succession, in parts of the Cape Province, through the Cape and Karroo Systems." WILLIAM C. SIMMONS.

Green Lightning.

DURING a thunderstorm last night, a flash of lightning started from the top white, and about half-way down turned to a vivid green. Possibly I am very unobservant, but I do not remember ever to have seen green lightning before. H. H. STEPHENSON.

Y.M.C.A.,
Brantford, Ontario, Oct. 7.

The Germplasm and its Architecture.[1]

By Dr. F. A. E. CREW.

THE individuals of a generation die, but life is transmitted to its successor through the exercise of the function of reproduction. This handing on of the torch of life, in the more highly organised forms, consists in the union of the gametes, egg and sperm, to form the zygote, the new individual and the next generation, specific to the highest degree and embodying all the possibilities of individual development and of racial perpetuation. Each of the sexually distinct parents contributes but a single cell, so minute as to be far beyond the limits of the unaided eye, yet these gametes are the only material link between the generations, and across this, the narrowest of bridges, everything organic that one generation can receive from its predecessor must pass. The zygote exhibits none of these details of structure and of function which, when the individual has assumed its definitive form, will enable the observer to describe and to classify it, yet in this fertilised egg there must surely be something that predetermines much of the individual's future morphological, physiological, and psychological limitations.

That offspring do in general resemble their parents is so familiar a fact that its significance is either overlooked or over-emphasised. It has been accepted, without wonderment, that a multitude of characters is faithfully transmitted from generation to generation; that like tends to beget like; that it can be predicted confidently that every individual conceived will sooner or later exhibit those details of form and of function which characterise the species, the race, even the family to which it and its relatives belong. The doctrine of homogenesis still satisfies the biologist. It has equally long been recognised that no son is the 'carbon copy' of his father, that each individual is the first and the last of its identical kind; that indeed variation is universal. It may be assumed that out of accumulated anecdotes concerning the similarities and dissimilarities in characterisation exhibited by related individuals, there soon arose the notion that in their distribution there were suggestions of an orderliness, a regularity, that many characters were indeed being inherited and that the mode of their inheritance was not a haphazard affair but was surely subject to certain rules. Thus it would soon become inevitable that the human mind, in its inherent desire to trace and to describe order in Nature, should seek some mechanism which in its functioning could account for this observed orderliness. A consideration of the observed facts of organic inheritance enabled man to form a general theory of inheritance, a speculative thought-model of what the architecture of the hereditary material might be.

The question to be answered was, "How is it that like begets like?" In the latter half of the eighteenth century it was customary to appeal to *vires formativae*, hereditary principles, hereditary tendencies, by the aid of which the seed grew into the likeness of its parents. In an age when materialism was not gross and when the microscope was most imperfect, it was inevitable that scientific men should resort to merely verbal explanations, which at best were gestures of respectful ignorance and of admiration. But improvements in techniques and additions to knowledge quickly eroded such purely metaphysical hypotheses.

During the seventeenth, eighteenth, and the earlier part of the nineteenth centuries, the most favoured explanation of the facts of inheritance and of development was some form of the theory of preformation and evolution. According to this, the egg, or the sperm, contained within it a perfect but miniature model of its parent, preformed though invisible, which required only to become unfolded, evolved, in order to reveal itself. This theory of ontogeny was extended to include phylogeny also, and it was taught that within this miniature was a second, and within this a third, and so on in increasing numbers until all the future generations were supplied; within mother Eve it was estimated were some two hundred thousand million homunculi, one within the other, like the components of an infinite juggler's box of which there is no end. Ovist and animalculist debated violently, yet both were agreed in this, nothing was generated, and what was thought to be generation was but merely the enlargement of that which had pre-existed in an invisible form. Haller it was who declaimed, "Es gibt kein Werden"—there is no becoming—and the theory held sway until it staggered under the blows of Wolff's demonstration of the gradual development of the apparently simple into the manifestly complex. Wolff demonstrated that development was epigenetic, taking the form of a true series of transformations, and was not merely the enlargement of what previously had been invisible.

Just, however, as the preformatists could not easily account for the origin of their miniatures, so Wolff was unable to explain the demonstrated fact that the end-result of epigenetic development was an individual similar in characterisation to its parents, save by an appeal to the aid of a *vis corporis essentialis* by which the plastic organic material controlled its own destiny. Wolff was not unique in this; it has ever required the severest intellectual ascetism to banish from the scientific mind this tendency to explain by an appeal to a metaphysical conception, and since his time this inherent force has been recreated by many who have been at pains to give it another name; purposive striving, emergent evolution, creative evolution, are examples, for man ever creates his gods and imprisons them in the machines that he invents.

These theories in their sequence were signposts along the road we are travelling, for out of them emerged the firm conviction that the future in-

[1] Evening discourse delivered at the Leeds meeting of the British Association on Sept. 5.

dividual must be materially implicit in the gamete, and that not only did this single cell contain the rudiment of the next generation but also those of all succeeding generations as well. Soon the conception arose that the germ-cells were distinct from the rest of the body; that they were to be looked upon as centres of contributions from the different parts of the body. The central problem of heredity came to be that which was concerned with the manner in which the various heritable qualities of the individual got into the germ-cells produced by that individual. Theories of pangenesis, which had flourished from the time of Democritus, were revived and extended but soon gave ground as the conception of germinal continuity, finding support in the newer facts of cytology, gripped the mind. It had been shown that in certain instances it was possible to distinguish between those cells of the segmenting zygote which were destined to become the reproductive organs and those which were to become the body of the individual. The distinction between the ontogenetic and the phylogenetic became more and more emphasised as time went on, and soon it became evident that in the fact of material continuity between the reproductive elements of generations must be found the solution of the problem as to how it is that like tends to beget like.

To Weismann is mainly due this replacement of pangenetic theories by genetic. He taught that the germ-cells were to be regarded merely as parts of an unbroken line of germplasm, the bearer of the heritable qualities; that this germplasm, in certain circumstances, usually the union of two of its constituent germ-cells, frothed up and produced a great excrescence, the somatoplasm, the body of the next generation, and continued its existence therein; that the germplasm was immortal, the body mortal; that the germplasm had existed from the very dawn of life, whereas the body was formed afresh in every generation; that when the zygote divided, some of the resulting cells were set apart at once and took no further part in the building of the body, but remained, later to become the germ-cells of the individual.

Weismann postulated that what is actually continuous is the germplasm of definite chemical and specific molecular constitution, that a continuity of actual germ-cells is rare, but that a continuity of intact germplasm is the rule. According to such a genetic theory of inheritance, an individual is like its parents, not because it is produced by them but because both parent and offspring are produced from the same stock of germplasm. The somatoplasms of father and son are developments at different times from one and the same continuous stream of germplasm. Organic inheritance, all that the individual possesses in virtue of the hereditary relationship, implies a rhythmical repetition of a definite, and on the whole, similarly repeated series of events leading to the production of an individual which liberates germ-cells capable of initiating the same process.

The problem of organic inheritance thus became restated. It was now concerned with the manner in which the heritable qualities of an individual were represented in the germ-cells which in their union produced the individual; the need for critical experimental investigation of the problem of heredity and variation was recognised and the stage was set for the re-entry of Mendel. When the records of his work of some forty years before were brought to light in 1900, it was recognised that in them was confirmation and extension of the essentials of Weismann's hypothesis, but that no longer was it necessary to invoke a hypothetical mechanism for the distribution of the hereditary factors, for by this time independent cytological investigation was disclosing a satisfactory mechanism within the living cell.

Mendel had taken for his problem the question as to the exact manner in which the definite and true-breeding varieties within a species are related one to the other. He considered the individual not as a unit in inheritance, but concentrated his attention upon the mode of inheritance of pairs of sharply contrasted characters. The method he adopted was that of hybridisation, and he kept accurate pedigree records showing the ancestry and the characterisation of each individual. He counted the number of individuals in each generation and the numbers of dissimilar kinds, and was able to give an exact mathematical statement of his results. His was the first attempt to reduce the phenomena of inheritance to a measurable basis, for he employed the exact quantitative methods that scientific discipline demands. The man, the method, and the material made discovery certain. He found that in the case of every one of the seven pairs of contrasted characters of the culinary pea with which he dealt, the mode of inheritance was the same. Out of his experimentation there emerged clearly the verifiable fact that when one or more pairs of alternative characters are involved in a breeding experiment, there is in the second hybrid generation an orderly reappearance of these characters in definite numerical proportions.

Mendelism is a scientific theory relating to the distributive mechanism of organic inheritance which, like most other hypotheses of this kind, postulates the existence of a number of individual particles of substance-factors—in the germplasm—each of which in its action influences the development of some particular character. It does not require that these particles shall be concerned solely with hereditary transmission. It demands that in respect of any particular character the individual must receive from its parents, one from each by way of the gamete, two factors, either similar or dissimilar according to whether or not in the respect of this character the parents were alike or different. It requires that when the individual in its turn elaborates its reproductive cells, into each ripe gamete there shall pass one or other, but not both, of these factors. The gamete can contain but a single set of factors; the zygote a double set, and of these one set shall have been received from each parent. Thus the zygote may be hybrid in respect

of a character or characters since one or more pairs of factors in its constitution may consist of dissimilar mates: the gamete, on the other hand, cannot be hybrid, since factorially it is constitutionally simplex. The theory postulates that the association of dissimilar factors in the zygote is not attended by any adulteration effect upon them.

The Mendelian method of character analysis, ardently pursued during the first decade of the twentieth century, made it perfectly clear that if there were actually such a thing as a material basis of organic inheritance, if the germplasm did exist in fact, then in the cell there must be some unit which is structurally continuous through all cell divisions from the first cleavage of the fertilised egg to the liberation of the ripe gametes by the resulting individual; that these units must be present in duplicate in the zygote; that they must segregate into single components at some point before the functional gametes are finally formed, and that in the zygote these units must be present in pairs.

As was to be expected, it was not long before results were obtained from breeding experimentation which demanded extension and modification of the theory as originally promulgated by Mendel. Mendel's second law of the independent segregation and recombination of factors, for example, was found by Bateson and Punnett not to apply invariably. In several instances this free assortment was found to be more or less absent, and characters in their transmission from generation to generation exhibited the tendency to remain together. In appropriate matings and in those cases in which such linkage was evidenced, linkage proved to be incomplete and the percentage of recombination classes was found to be constant under controlled and stable conditions of experimentation and to be characteristic of a particular mating. With greater experience came the power to predict the percentage of such recombination classes in any experiment involving characters which exhibited this linkage relationship and such prophecy has been abundantly verified, and no exceptions so far have occurred to the rule. Upon this general result the hypothesis of the linear arrangement of factors within the germplasm is based.

As a result of this more recent experimentation, the factorial theory of organic inheritance has become modified and greater have become the demands which must be made upon the germplasm. It is now generally accepted that the hereditary characters are referable to paired elements in the germplasm which are held together in a definite number of linkage groups; that the members of each pair of elements separate when the germ-cells mature, in accordance with Mendel's first law, and in consequence each gamete comes to contain one set only; that the members of different linkage groups assort independently, in accordance with Mendel's second law; that an orderly interchange—crossing-over—takes place at times between the elements in corresponding linkage groups; and that the frequency of crossing-over furnishes evidence of the linear order of the elements with respect one to another. The germplasm in its nature and architecture is now required to be such as can accommodate the facts of linkage, of crossing-over, and of the linear order of factors.

(To be continued.)

Standards of Performance of Heat Engines.

THE discovery of the interchangeability of heat and mechanical work has been followed by progressive efforts to attain the maximum ratio for the efficiency of conversion of the former into the latter. It is significant of the limitations which attach to such conversion, and the remoteness of a complete solution, that after a century of progress we are still striving to express this efficiency as the ratio of a ratio. This reflection is suggested on perusal of the report recently issued by the Committee of Heat Engine Trials under the auspices of the Institution of Civil Engineers, one of the objects of which is to determine a suitable standard of performance, which shall have a known efficiency ratio, and to express the actual performance of an engine as a ratio thereof.

The limitations are well recognised. There are first of all those of a thermodynamic nature, which prescribe that within given limits of temperature the defect from perfect conversion cannot be less than the ratio of the minimum to the maximum absolute temperature; in other words, the maximum possible efficiency is given by $(1 - T_2/T_1)$; this is known as the Carnot efficiency, belonging to a perfect heat engine working on such a cycle that heat reception takes place at, and only at, the maximum temperature T_1, and heat rejection solely at the minimum temperature T_2.

It might be thought at first that the quest for an intermediate ideal could end here and that this simple expression for the maximum efficiency thermodynamically possible would answer the requirements. But there are further limitations of a practical nature on account of which the Carnot efficiency ratio is still a long way removed from what can be obtained in practice, and it is preferred to soothe our baffled ambition by adopting a lower standard more in keeping with what can actually be realised.

The nearest approach to the Carnot cycle is made in the steam engine when using saturated steam. Here, except for the heating of the feed water up to boiler temperature, the whole of the heat reception takes place at a constant temperature, and, if we assume no losses by friction, radiation, etc., the whole of the heat rejection takes place at condenser temperature. This is known as the Rankine cycle. The only departure from the Carnot cycle is in the replacement of the compression stage by the simpler process of elevating

the condensed water to boiler pressure in the feed pump. The consequent almost complete elimination of negative work gives the Rankine cycle a great practical superiority, and the early success of the steam engine as a prime mover was largely due to its ability to work on this cycle with saturated steam.

The Rankine cycle was therefore considered a more suitable standard of comparison than the Carnot cycle, and came into general employment by makers and users of reciprocating engines. It was adopted as the criterion of performance by the first Committee on Heat Engine Trials in 1898, and reaffirmed by the Committee of 1903–1905. The processes of the Rankine steam cycle are (1) reception of heat at constant pressure, (2) adiabatic expansion, (3) rejection of heat at a constant pressure and temperature, (4) restoration of the feed water to boiler pressure.

With the adoption of superheated steam, an extension of the cycle was necessary, to include the superheating process, but since, when employing superheat, evaporation takes place at a temperature below the maximum of the cycle, the Rankine cycle becomes further removed from the Carnot cycle, in the sense that it does not follow the latter to the full realisation of the increase of efficiency made possible by the higher maximum temperature.

In later practice it has become customary to speak of the Rankine cycle as though it were synonymous with a modified cycle in which the volume of the feed water is neglected, the work done in the cycle being then equal to what is known as the 'available energy' of the steam between its conditions at admission to, and exhaust from, the engine. As a standard of measurement of the efficiency of the engine itself there is much to be said for it, and the development of the turbine has familiarised us with the conception of an engine steadily extracting from the steam its available energy.

Finally, the properties of steam have now been so thoroughly explored and reduced to a thermodynamically consistent basis, that it is a comparatively simple matter to calculate the available energy of the steam even under complicated conditions of supply such as are entailed by the modern practice of bleeding steam from turbines to heat the feed water, and of reheating the steam at intermediate stages of its expansion. The Committee, which has just issued its report, has accordingly recommended referring the performance of the engine to the available energy in the steam according to the conditions of its utilisation, which energy can be calculated by well-known methods.

While this serves excellently for the appraisement of the engine performance, it must not be overlooked that attention has been diverted from the heat engine proper and confined to that part of it only which carries out the process of expansion. The heat input as evaluated in the report is also different from the heat input of the Rankine cycle, in that it includes the small amount of 'total heat' put into the feed water by the feed pump. The efficiency thus calculated for the standard of performance is no longer that of the Rankine cycle heat engine.[1] For moderate pressures the differences are small, but they become appreciable when high steam pressures are employed.

A similar approximation is not possible for the internal combustion engine, since in this case the negative work is considerable. It results that the difficulty of finding a satisfactory standard is increased. The Committee has re-affirmed the conclusions of the Committee of 1903, which recommended the adoption of the air-engine standard, namely, an engine working with a perfect gas of the same density as air and operated between the same maximum and minimum volumes as the actual engine. This recommendation of the earlier Committee was qualified by the admission that amendment might be required later on the acquisition of more accurate data regarding the variation of specific heat with temperature.[2] Sir Dugald Clerk has pointed out that the practical thermal efficiencies are of the order of 70 per cent. of the air standard efficiency for most economical mixtures, and a note in the new report discusses the effect of variable specific heat upon the efficiency of the air cycle, giving curves for various types of engine. The correction factors so introduced are considerable and vary with the heat input, that is to say, with the mixture strength of the actual engine and also with the type of engine.

The Report recently issued is, however, a veritable mine of information. In addition to the discussion of the thermodynamics of the subject in the introductory notes, forms of record are given making available to users of heat engines and to research workers authoritative methods of recording and reducing the results of efficiency and capacity trials. The Report takes within its scope boilers and steam engines for land and marine purposes, gas producers, gas engines, heavy oil engines, and petrol or paraffin engines. Schedules are presented for each section indicating in comprehensive detail the various measurements to be made, each leading up to a heat balance account for the plant under test. The value of these schedules is enhanced by copious notes for the guidance of the engineer employing them.

A valuable addition to the Report is a series of appendices, dealing with instruments and methods for the most important of the measurements that are required. In virtue of all this additional matter, this Report on the tabulation of engine trials has been elevated to the rank of a text-book of the subject, and a useful work of reference.

[1] If H', H'' be the total heat at beginning and end of adiabatic expansion, h' the total heat of water at condenser temperature and pressure, standard efficiency ratio as adopted $= \frac{H'-H''}{H'-h'}$, efficiency of Rankine cycle $= \frac{H'-H''-w}{H'-h'-w}$, w being work (in heat units) of the feed pump. See Callendar, "Properties of Steam," p. 219.

[2] *Minutes of Proceedings of Institution of Civil Engineers*, vol. 162, p. 307.

Rothamsted Experiments.[1]

A PERIODIC summary on the work at the Rothamsted Experimental Station is an essential if teachers and others are to keep in touch with its activities. Its place is between the fleeting impressions of a summer-day visit, and the detailed monographs and specialised publications. This is recognised in the preparation of the report, and one can obtain in brief the more outstanding results, in this case for the years 1925 and 1926. If the critic sometimes feels that 'research in agriculture' is merely a phrase, he will find that it is a reality at Rothamsted.

The many-sided activities of the station of to-day are at once apparent from the staff-list, and one recalls the few workers and the meagre equipment of the Rothamsted of Lawes, Gilbert, and Warington. Yet even then the reputation was being made that now attracts temporary workers from all parts of the world. The large proportion of biological workers is noteworthy as evidence of the recognition of a living plant and a soil where organisms play an important part. There has also been an increase in the departments concerned with statistics and conducting of field experiments. The activity of the director and the staff is evident from the number of papers published, and the student struggling to keep pace with the present large output of agricultural literature will be grateful for the terse summaries of the more strictly scientific papers, extending to thirty pages of this report. Another direction in which the station has done valuable work is in organising conferences, which have been of the nature of symposia on particular aspects of agricultural science, or meetings of farmers with the staff and other scientific workers for the discussion of recent developments and their significance in agricultural practice. Then there are the extra-mural activities, such as organising displays for the Royal Agricultural Show and other exhibitions, and the work of the guide lecturer, who demonstrates the station's work to visitors and, during the winter months, delivers lectures to farmers' and other institutions on agricultural topics.

The key-note of the earlier Rothamsted work may be described as propaganda on the use of fertilisers, but as these are now incorporated as part of ordinary farm practice, modern problems are concerned with details that are factors of prime importance in crop production. The sixty-year experiments are still continued, but are amplified by being repeated in other parts of the country, and through more exact observations on the crop-plants. Thus it is no longer the work of a research station to persuade farmers to use artificial manures, but it is still a problem how to get the best value out of the manures. There seems to be good evidence that at Rothamsted and elsewhere 1 cwt. of sulphate of ammonia may be expected to give an increase of 20 cwt. in the case of potatoes, and 4 cwt. or 8 bushels for barley. The results for phosphates and potash are not so regular, although the fertility of the soil will almost certainly decrease if these are not maintained.

The interaction of one manure with another is also being investigated. In recent years increased attention has been given to minerals not actually plant nutrients, but influencing growth; boron, silicon, and manganese have been subjects of recent papers. Experiments on chlorides show that muriate of ammonia raises the yield of barley, not by increasing the numbers of ears but by improving the yield of grains per ear; in other words, chlorides appear to increase the movement of food materials towards the grain. The nitrogen content of barley, so important in malting, has also been under experiment, and results are given.

Since 1921 sheep-grazing has been included in the programme, thus supplementing the original manuring of grassland plots where the results were limited in application because they were investigated for hay yield only. Grazing complicates the problem, and the period of these experiments has been too short to allow of conclusive results. There is evidence that the amount of soluble phosphates in slag is only a rough measure of its utility. Results bear out the recognised fact that good land does not show so much response as poor land, or as the report puts it: "Grassland is not readily improved by slag if an acre of it yields some 200 lbs. live weight increase in sheep; the striking results are obtained on land giving only 50 or less lbs. increase per acre."

Methods of field experimentation are being intensively studied, as shown by the number of publications dealing with these or including them in arriving at results. A new departure is the staff and field laboratory for making measurements on the growing plant, since it has been found that in this way more useful information is obtained than by using weighings at the end of the experiment alone. The figures obtained are now handled by the statistical staff to estimate error, etc. Reasons are given for the adoption of 'standard error' (p. 122), and the merits of 'the Latin square' and 'randomised blocks' are discussed (p. 28). The soil physics department indicates its attempts to amplify the empirical rules of cultivation into a science. The studies on soil resistance as measured by the dynamometer, are illustrated by a diagram of Stackyard field showing the easing in plough-pull after 'chalking'. Other problems bear on soil texture as distinct from chemical properties.

Soil microbiology, another recent development, is briefly explained, including some applications in practice, namely, inoculation of leguminous crops, partial sterilisation of soils, and fermentation of cellulosic materials to produce artificial farm-yard manure. Other departments are concerned with losses of crops, including studies on what is involved in the resistance of so-called immune varieties. Altogether the report is not merely informative, but is also strongly suggestive of possible lines for demonstration and research; hence it should be in the hands of all interested in the principles and practice of agriculture.

[1] Lawes Agricultural Trust: Rothamsted Experimental Station, Harpenden. Report 1925–26, with the Supplement to the "Guide to the Experimental Plots" containing the Yields per Acre, etc. Pp. 156. (Harpenden: Rothamsted Experimental Station, 1927.) 2*s*. 6*d*.

News and Views.

THE following awards have been made by the president and council of the Royal Society, and the King has approved the awards of the Royal Medals: The Copley Medal to Sir Charles Sherrington for his distinguished work on neurology; a Royal Medal to Sir Thomas Lewis for his researches on the vascular system, following upon his earlier work on the mammalian heart-beat; a Royal Medal to Prof. J. C. McLennan for his researches in spectroscopy and atomic physics; the Davy Medal to Prof. A. A. Noyes for his work in physical chemistry, especially on the subject of electrolytic solutions; the Buchanan Medal to Dr. Major Greenwood for his statistical researches and other work in relation to public health; the Hughes Medal to Mr. W. D. Coolidge for his work on the X-rays and the development of highly efficient apparatus for their production.

AT the meeting of the Royal Society on Nov. 3, Mr. Stanley Baldwin was elected a fellow of the Society under Statute XII., which provides for the election of persons who "have rendered conspicuous service to the cause of science, or are such that their election would be of signal benefit to the Society." The following is a list of those recommended by the president and council of the Society for election to the council at the anniversary meeting on Nov. 30:—*President*, Sir Ernest Rutherford; *Treasurer*, Sir David Prain; *Secretaries*, Mr. J. H. Jeans and Dr. H. H. Dale; *Foreign Secretary*, Sir Richard Glazebrook; *Other Members of Council*, Dr. E. D. Adrian, Sir Hugh Anderson, Dr. F. W. Aston, Dr. F. A. Bather, Sir Archibald Garrod, Sir Thomas Heath, Prof. A. Lapworth, Prof. J. C. G. Ledingham, Prof. F. A. Lindemann, Mr. J. E. Littlewood, Mr. C. Tate Regan, Prof. A. C. Seward, Prof. G. Elliot Smith, Dr. T. E. Stanton, Sir Gilbert Walker, Sir James Walker.

THE Gallic race can boast of a long list of front rank and even alliterative mathematicians—Laplace, Lagrange, Legendre, Picard, Poincaré, Painlevé, to mention only a few—but M. Paul Painlevé provides that rare combination of mathematical and political eminence that is almost without parallel. While the subject with which he will deal on Nov. 15 in his address at the Royal Institution on "Les conceptions modernes de la matière et de la science classique" will be primarily physical and philosophical, his mathematical energies have been devoted mainly to the purer aspects of that subject, although not exclusively so. Thus in his paper in the *Bulletin Astronomique* (1898) he made important contributions to the problem of three bodies, but the focus of his work has primarily been differential equations and the theory of functions. One of his earliest papers on the singularities of functions, "Sur les lignes singulières des fonctions analytiques" (*Comptes rendus*, 1887), enunciates a number of important theorems relating to the continuity of the boundary values assignable to Dirichelet's problem. He extended the conception of the Schwarzian derivative to differential equations of the third order, deriving the invariants and indicating the procedure to be adopted towards solution. In his crowned memoir, "Sur les équations différentielles du premier ordre" (1891), he propounded the theorem named after him that the points of indeterminateness, and in particular the essential singularities of the integral of an equation, are fixed points determined by the equation itself.

PAINLEVÉ'S Stockholm Lectures (1897), largely based on the theory of rational transformation of curves and surfaces, contain some of his best work. They treat of the analytical theory of differential equations and examine the descriptive properties of the integrals. Many of his later memoirs in the *Comptes rendus* deal directly with various problems in Function Theory—functions with unlimited essential singularities and expansions in series. As an extension of the theory of continuation he showed how to construct a single expression in the form of an infinite series of polynomials which would be a valid representation of a function over an extended domain. It is perhaps no exaggeration to say that much of the classical treatment of differential equations might never have been written were it not for Painlevé's investigations on that subject and on the theory of functions. In addition to his lecture at the Royal Institution on Nov. 15, M. Painlevé will speak at Cambridge on Nov. 16 on "Résistance d'un liquide au mouvement singulier d'un solide," and on Nov. 17 at the French Institute in London on "Absolu et Relativité." While at Cambridge, M. Painlevé will receive the honorary degree of doctor of science.

DR. A. W. HILL, Director of the Royal Botanic Gardens, Kew, sailed for Australia from Toulon on Nov. 4 on the invitation of the Commonwealth Council for Scientific and Industrial Research, Melbourne. Dr. Hill expects to reach Fremantle on Nov. 29, and will visit the various botanical, agricultural, and forestry institutions in Western Australia, and will then proceed to Adelaide, Melbourne, Sydney, and Brisbane, to study the various botanical institutions in the different States, under the auspices of the Commonwealth Council. He also hopes to attend the meeting of the Australian Association for the Advancement of Science at Hobart in January next. Dr. Hill will then proceed to New Zealand on the invitation of the Dominion Government, where he hopes to spend some three weeks. He is going on to Java, where he will visit the Botanic Gardens at Buitenzorg on the invitation of the Director, and visits will also be paid to the Botanic Gardens, Singapore, Department of Agriculture, Kuala Lumpur, and the Royal Botanic Gardens, Peradeniya, Ceylon. Dr. Hill expects to return to Kew about April 20 next year. This visit is being undertaken as an outcome of the recent grant to Kew from the Empire Marketing Board, which was made to enable the Director or some senior member of the staff to visit different parts of the Empire to study botanical questions and matters relating to economic botany.

SIR CHARLES MARTIN, director of the Lister Institute, upon whom the honour of knighthood was recently conferred, has been presented with his portrait by the staff of the Institute as a token of personal esteem and appreciation of his great services during the twenty-four years of his directorship. Subscriptions to the portrait were confined to present staff and research workers and to past members of staff during Sir Charles's directorate. The painting of the portrait was entrusted to Mr. Neville Lewis, and the finished work has given much satisfaction. The presentation of the portrait took place in the library of the Institute on Oct. 28, when Prof. Harden presided over a large company of past and present members of staff and research workers. Prof. Harden referred in eloquent terms to the scientific and administrative ability of the director, his versatility and helpfulness, and above all to his great personal charm and tact which have conduced so greatly to that domestic harmony which has ever been the pride of the Lister Institute.

MEMBERS of the British Association have from time to time discussed the desirability of the Association's applying for a Royal Charter. It has been felt that the Association would be strengthened in its work for the advancement of science by the possession of a charter, but the cost involved has hitherto acted as a deterrent. Mr. A. A. Campbell Swinton has now generously offered to bear this cost, and the Council has resolved to recommend the General Committee to accept his offer and to authorise the president and general officers of the Association to apply for a charter on its behalf. The possession of a charter would, moreover, enable the Association readily to avail itself of a proposal made by Mr. George Buckston Browne, who, it will be remembered, offered to purchase Darwin's house at Downe for the nation, in response to the appeal made by Sir Arthur Keith in his presidential address at the Leeds meeting of the Association. Mr. Buckston Browne has now expressed his desire that the trusteeship of the estate should be vested in the Association, and the Council will recommend the General Committee to accept this further generous offer.

THE preliminary notice of the proposed expedition to the Great Barrier Reef of Australia appeared in NATURE on Mar. 26 last. Circumstances have prevented the departure of the expedition this year, but the preparations have steadily progressed. At the meeting of the British Association at Leeds, a committee of Sections C, D, E, and K was appointed to organise the expedition for 1928. The second meeting of this committee was held at Australia House on Oct. 4, presided over by the chairman, the Right Hon. Sir Matthew Nathan, ex-Governor of Queensland, to whom the inception of the scheme is due. The aims of the expedition, which, it is hoped, will start in April next, are directly scientific, but it is anticipated that their realisation will throw light upon important economic problems. The leader will be Dr. C. M. Yonge, who will be accompanied by a staff including zoologists, botanists, a chemist, a surveyor, and, it is hoped, a geologist.

THE English committee will work in collaboration with the Great Barrier Reef Committee of Australia, the presiding genius of which is H. C. Richards, professor of geology in the University of Queensland, in carrying out the objects of the Expedition, which are "To examine a sector of the Great Barrier Reef from shore to ocean off Cairns, chart it accurately, surveying the associations of plants and animals on its surface, both qualitatively and quantitatively, study the food and power of lime formation in the same, and all such other matters as concern the formation and growth of that part of the reef." The secretaries are Prof. J. Stanley Gardiner and Mr. F. A. Potts, of the University of Cambridge. A sum of £8000 is required, of which, with the aid of grants from the Australian Committee, the Royal Society, the British Association, and private subscriptions from members of Section D, a sum of £2250 has already been secured. It is hoped that, in view of the importance of this survey both scientifically and economically, further generous contributions will be made by scientific and commercial bodies, and particularly by private individuals. The treasurer, the Hon. John Huxham, Agent-General for Queensland, or the Secretaries will be glad to hear from persons who may be willing to make 'grants in aid.'

THE Institution of Civil Engineers was founded by half a dozen young engineers in 1818, but it was not incorporated by Royal Charter until 1828, Telford then being president. In view of the approaching centenary of its incorporation, Mr. E. F. C. Trench devoted a part of his presidential address, delivered on Nov. 1, to a historical review of inland transport problems. Telford was famous for his roads, bridges, and canals, and in the revolutionary changes in the means of transport effected in the last hundred years, members of the Institution have taken a leading part. The earliest roads of England, said Mr. Trench, were due to the Romans and were maintained by the State. Central control, however, vanished in the fifth century, not to return until more than a thousand years later. For centuries upkeep and repairs were unsatisfactory. The first Turnpike Act of 1663 led to an improvement, and by the dawn of the railway era, some fifteen hundred stage coaches plied from London. The development of canals took place in the eighteenth century, and these for the first time provided easy and cheap transport for foods and minerals, resulting in a great incentive to industry, but the very success of the canals paved the way for a more flexible and quicker system.

MANY railroads were sanctioned early in the nineteenth century, but the steam railway era set in with the Stockton and Darlington Railway of 1825 and the Liverpool and Manchester line of 1830. In the 'forties, hundreds of separate lines were projected, but Parliament was opposed to amalgamation. It is true a select committee of 1844, presided over by Mr. Gladstone, declared that "each new line should be viewed as a member of a great system of communication," yet Parliament in 1853 passed a resolution "that no railway Bill containing any powers of amalgamation,

purchase, lease, working arrangement, or other combination of interest between different companies should be read a second time unless all such powers were struck out." The Railway Act of 1921 marked a complete change in the attitude of the Legislature. Referring to the present position of the railways, Mr. Trench showed what the companies have done to improve the services and yet effect economies. With the coming of the road motor vehicle, the virtual monopoly of the railways has come to an end. Railways, however, have spent £1,200,000,000 on land and tracks and expend £13,000,000 per annum in maintaining the tracks, while road vehicles found their track ready free of charge. Equity requires that the cost of the roads should fall on the road-users. In concluding his address, Mr. Trench said "that great and rapid as has been the advance achieved by the labours of the engineer . . . the true progress of civilisation depends equally upon corresponding developments in the less material fields of human thought and endeavour."

THE International Commission on the finds of alleged high antiquity at Glozel which was appointed by the Institut d'Anthropologie at the recent congress at Amsterdam is now at Vichy for the purpose of pursuing its investigations on the spot. Its arrival was preceded by that of Dr. Peyrony, who, as already announced, is in charge of the site under the Ministry of Education. The members of the Commission are M. Hammal (Belgium), M. Pittard (Switzerland), S. Bosch-Guimpera (Spain), M. Absalon (Czechoslovakia), Miss Garrod (Great Britain), and MM. Ferrer, Peyrony, and Favrot (France). As all the members of the Commission are of proved competence in handling archæological evidence, their findings should inspire confidence both as to impartiality and accuracy. It is to be hoped that they will bring to an end a controversy which has at times been conspicuously free from the atmosphere of calm detachment which is supposed to be appropriate to the discussion of scientific problems.

ALTHOUGH the season's excavations have only just begun, the reports which have appeared in the *Times* during October of the work already carried out at Beisan by the Palestine Expedition of the University Museum of Philadelphia gives further promise of fulfilment of the great expectations from this site. As exploration is extended in the lower levels of the eight strata identified, which cover a period of thirty-three centuries and date from the time of Amenophis III. to that of the Crusaders, the results become increasingly important to both the historian and the archæologist. Already this season two Canaanite temples, dated at 1500 B.C., have been discovered. They are the earliest yet known and throw an entirely new light upon early Canaanite religion. In one of the temples were two altars: one for cult objects, the other for sacrifice. An outer sacrificial altar exemplifies details of the methods employed in carrying out the ritual. It has a channel to carry off the blood, a socket and peg for tethering the victim, and also a socket for the pole on which the carcase was dressed. Near by were a sacrificial dagger, the shoulder blade of a bull, and a bronze pendant for suspension on the neck of the victim. On the level identified with the time of Rameses II. was found a door jamb, showing the figure of the builder of the temple of Dagon mentioned in Chronicles.

AN earthquake was recorded at Kew Observatory on Nov. 4, commencing at 14 hours 3 minutes 14 seconds G.M.T. The distance of the epicentre is estimated to be 5540 miles. The New York correspondent of the *Times* states that earthquake shocks were felt along the coast of California on the morning of Nov. 4, and that five miles of track belonging to the Southern Pacific Railway in Santa Barbara County were thrown out of alinement but no one was injured.

IN his presidential address to the North-East Coast Institution of Engineers and Shipbuilders, delivered on Oct. 28, 1927, Mr. Maurice S. Gibb inquires into the probability of the British engineering industry being able to restore its prestige by lowering its costs of production sufficiently to enable it to retail its wares at attractive prices. He comes to the important conclusion that the industry is not so much in need of scientific investigation as of the ability to apply the scientific knowledge obtained. Valuable work is being done by the various research associations, but the real difficulty begins when the results obtained come to be applied to the everyday work of production in the office and shop. Referring to the factors which assist the industry in benefiting from the results of research, the teachers in technical colleges are commended, and the foundry metallurgist and works laboratory staff are valuable connecting links between science and production.

As examples of advances directly attributable to the proper application of scientific knowledge, Mr. Gibb referred to several improvements in materials and methods. The production of special steels has made possible the modern aircraft and the higher cutting speeds of machine tools, and now the stainless variety opens up a new field of utility for iron and steel. Boiler plates, bronzes, and cast iron have also been considerably improved in quality. In regard to methods, the measurement of machine parts is now done much more scientifically and accurately; in mass production, the timing of the production of component parts is more exact; temperatures are accurately measured and recorded, the thermo-couple, by which temperatures at various places can be read at one centre, being now a practical instrument in constant use in engine and boiler rooms, in foundries and in other furnaces.

ANOTHER important aspect of the case is the economic effect of oil replacing coal as the principal fuel for power production. Coal is Great Britain's greatest material asset and contributes largely to increase our exports, so that it is in the national interest to develop the use of coal rather than oil. The engine builders and purchasers naturally take a narrow commercial view, and the latter demand and the former produce

the engine that will give the best financial return. However, taking a broader view, the cost of our engineering products will be increased as the coal industry diminishes, and it is therefore a matter of importance to the whole engineering industry. It is not suggested that the development of the internal combustion engine should cease, but rather that the problem should be approached from the opposite direction by further developing the steam engine. Whatever it may have already done, the coal industry itself is invited to assist in the work of investigating the possibilities of the coal-using engine, and this work, being of vital national importance, should receive attention before it is too late.

IN his inaugural address to the Institute of Transport, delivered on Oct. 10, Mr. Roger T. Smith discussed the results already obtained on the Swiss Federal Railways (the C.F.F., Chemins de Fer Federaux). One of the reasons of the success of the electrification scheme of the C.F.F. is that an electric locomotive can provide about four times the increase in pull for the same drop in speed which the steam locomotive can give. This summer the average trailing load hauled on the C.F.F. by an electric locomotive was 100 tons greater than the average load hauled by a steam locomotive. At the same time, the average speed was increased by about 20 per cent. Unlike the steam locomotive, the electric locomotive can go up steep gradients with very little loss of speed. The saving of time over steam working in ordinary stopping passenger trains is considerably greater than for express trains owing to the high accelerating power of the electric locomotive. Owing to the special conditions in Switzerland, for example, the steep gradients and the many lengthy tunnels, electric traction has many advantages. Many international trains also run over the Swiss lines. It is difficult, therefore, to deduce from these results what the corresponding results in Britain would be. Mr. Roger Smith, however, has made careful estimates for main-line electrification schemes in Great Britain over long routes. He finds that the savings in working expenditure, as compared with steam, will pay on the cost of electrification from 5 per cent. on fairly busy lines to as much as 12 per cent. in lines fully worked with dense mineral and goods traffic throughout the twenty-four hours.

ELECTRICITY was first introduced into mines as an obvious solution of the problem of driving in a confined space machinery for coal cutting, for haulage, and for working pumps. Safety of life is the dominant factor, and every modern development of underground gear is in this direction. In an article in the *Electrical Times* of Nov. 3, Prof. W. M. Thornton lays stress on the improved lighting of the underground roads and on the elimination of the horse as a means of traction. The oil lamp is useful as a gas detector in mines, but it will inevitably give place to portable electric lighting sets. Research has shown how much the comfort of the worker depends on the absence of a feeling of apprehension. There is reason for believing that this nervous feeling combined with bad lighting produces that singular eye disease called nystagmus, the incidence of which seems almost to be sporadic. The great electrical haulages found in many pits are the most active of all the means by which electricity saves the miner. The whole safety of underground workers, as in that of pedestrians in a busy town, depends on the probability of a set of dangerous factors occurring simultaneously. It is to reduce this probability that the Safety in Mines Research Board investigations are directed. The spark occurring when an electric lighting circuit is broken may cause an explosion. Prof. Thornton has shown that it is possible to go on breaking a 500-frequency 200-volt lighting circuit carrying 20 amperes in an inflammable mixture of coal gas and air for hours without anything happening. With 200 volts direct current, ignition followed at once when the current was 1 ampere. This suggests the possibility of using higher frequencies for lighting in mines. It has to be remembered, however, that by far the greatest number of accidents in mines is caused by falls of the roof and side. The only remedy is to erect with greater care and use improved mechanical means of support.

AT the ordinary scientific meeting of the Chemical Society on Thursday, Nov. 8, Sir Joseph J. Thomson was elected an honorary fellow of the Society.

WE much regret to announce the deaths of Dr. D. G. Hogarth, C.M.G., Keeper of the Ashmolean Museum, Oxford, and president of the Royal Geographical Society, on Nov. 6, aged sixty-five years; and of Sir William Galloway, the distinguished mining engineer, on Nov. 2, aged eighty-seven years.

THE annual general meeting of the Mineralogical Society was held on Nov. 1, and the following officers were elected:—*President*, Dr. G. T. Prior; *Vice-Presidents*, Sir John Flett, Sir Thomas Holland; *Treasurer*, Mr. F. N. Ashcroft; *General Secretary*, Mr. W. Campbell Smith (Natural History Museum, S. Kensington, S.W.7); *Foreign Secretary*, Dr. J. W. Evans; *Editor*, Dr. L. J. Spencer.

THE British Mosquito Control Institute, Hayling Island, Hants, announces that arrangements have been made for short two- or three-day courses of instruction in mosquito control work to be given during the first week of each month. The first course will commence on Tuesday, Dec. 6, and will include (1) lectures dealing with the life-history, habits, and structure of mosquitoes, and various methods of control; (2) practical field work in the application of remedies; and (3) identification of mosquitoes in the laboratory. The instruction provided is intended primarily for those who wish to obtain an elementary knowledge of the subject in the shortest possible time. The two-day course is sufficient for this purpose, but those who wish to pursue their studies further will have an opportunity to do so on the third day. The Institute is also available for the use of research students, and is fully and admirably equipped for all these purposes. The courses will be of interest not only to persons going abroad,

but also—and perhaps especially—to medical officers of health and others in Great Britain seeking information regarding the control of local mosquito pests. Full information can be obtained from the Director of the Institute.

A SPECIAL number of the *Zeitschrift für physikalische Chemie* has been dedicated to Prof. Ernst Cohen, of the University of Utrecht, to commemorate the twenty-fifth year of his professorship.

READERS interested in South Africa should obtain catalogue No. 501 of Messrs. F. Edwards, Ltd., 83 High Street, Marylebone, W.1, which gives the titles, and, in many cases, other particulars of some 700 books, etc., relating to that part of the globe. A later catalogue, No. 502, deals with nearly 900 works relating to the Near East and Egypt.

PROF. A. N. WHITEHEAD has a new book entitled "Symbolism: its Meaning and Effect," appearing through the Cambridge University Press. The same house will publish almost immediately "Psychology and the Soldier," by F. C. Bartlett. The work aims at showing how a knowledge of psychology and social psychology can be brought to bear upon the selection and training of recruits, the maintenance of discipline, and the development of morale. It also gives a brief account of some of the mental disorders of warfare and of their treatment.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A special librarian at the Institute of Metals—G. Shaw Scott, Secretary, 13-14 Members Mansions, Victoria Street, S.W.1 (Nov. 15). A temporary draughtsman under the Directorate of Technical Development, Air Ministry—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2 (Nov. 18). A head of the department of mechanical and civil engineering at Loughborough College—The Principal, Loughborough College, Leicestershire (Nov. 21). A junior research officer in the Institute of Animal Pathology, Royal Veterinary College—The Director, Institute of Animal Pathology, Royal Veterinary College, Camden Town, N.W.1 (Nov. 29). An assistant in the pathology department of the University of Aberdeen—The Secretary, The University, Aberdeen (Nov. 30). Two research assistants in the School of Tropical Medicine Laboratory, Freetown, Sierra Leone—The Hon. Dean, School of Tropical Medicine, Pembroke Place, Liverpool (Dec. 1). A telephone engineer under the Egyptian State Railways—Office of the Chief Inspecting Engineer, Egyptian Government, 41 Tothill Street, S.W.1. A teacher of advanced engineering calculations at the Central Polytechnic, Croydon—The Principal. An assistant at the Harper Adams Agricultural College, for special crop experiments—The Principal, Harper Adams Agricultural College, Newport, Salop.

Our Astronomical Column.

SHOWER OF LARGE METEORS.—Mr. W. F. Denning writes that "on Oct. 31 an assistant watching the sky from his garden counted 51 meteors during the night. Of these, five were as bright as, or brighter than, Venus, and several others were equal to Jupiter. The objects were not directed from one system but from several, the principal of which were as under:

ϵ Arielids: 42° + 23°	12 meteors.
α Arielids: 33 + 19	8 meteors.
γ Andromedids: 27° + 43° . . .	8 meteors.

The bright meteors were nearly all conformable to one or other of these streams. The two in Aries have often been observed before, but the Andromedids have been very little in evidence at the end of October in past years. One of them, as bright as Venus, observed at $20^h\ 32^m$ G.M.T. on Oct. 31, was also seen by Mr. Pye-Smith at Beckenham, Kent, as it passed through the central region of Perseus and disappeared a little to the left. The radiant point is indicated at 27° + 43° and the height of the meteor 65 to 27 miles above the mouth of the Thames from north of Margate to east of Southwold. The observer at Kent mentions that the light of the object illuminated his garden, and no doubt many metropolitan residents witnessed the flight of the meteor."

THE NEBULOSITY AROUND NOVA AQUILÆ III.—Shortly after the appearance of Nova Aquilæ III. (1918), Prof. Barnard discovered a bright nebulous envelope, about 0″·7 in diameter, surrounding the star. Later observations by Barnard and Aitken showed that this envelope was gradually expanding and fading, until in 1921 it became too faint for visual observations. A series of photographs were taken in 1926 with the Mount Wilson 100-inch telescope, and the results are described by Hubble and Duncan in the *Astrophysical Journal*, vol. 66, p. 59. The photographs show the envelope as a sharp circular disc, of about 16″ diameter, with the star in a central position. The expansion therefore appears to have continued at a uniform rate of 1″·0 annually, which is in accordance with the early visual observations. Assuming a linear rate of expansion of 1700 km./sec. (based on radial velocity observations from early spectrograms), this would imply a parallax of 0″·0028, corresponding to a distance of 360 parsecs.

IDEAL LUNAR LANDSCAPES.—*L'Astronomie* for September contains an interesting article by M. Lucien Rudaux, contrasting lunar and terrestrial landscapes. The blackness of the sky and the absence of all aerial perspective, in addition to the great difference in the character of the surface features, increase the difficulty in making correct mental conceptions of the appearances that would be presented to an observer on the moon. The author gives a series of carefully designed pictures of various lunar landscapes. In one of these we are supposed to be standing at the bottom of a deep crevasse. One wall is brightly lit up by the sun; the other is faintly visible by reflection from it. The shadows must be far from black in regions where a large extent of sunlit cliff is in the field of vision. Another picture shows the aspect of one of the smaller craters soon after sunrise; in another we are situated in the centre of the floor of Plato; only a few of the highest summits in the surrounding rampart are visible, the rest of it is below the horizon. There is also a picture supposed to be taken at the moment before sunrise. A portion of the corona and chromosphere have already risen, also the zodiacal light. A reconstruction is given of the isolated mountain Pico near Plato. It is much less precipitous than one is apt to imagine from its tapering shadow. In fact, its height appears to be only one-tenth of the diameter of its base. A series of careful drawings of this kind are a useful aid in forming correct notions of the nature of the lunar surface.

Research Items.

THE DISTRIBUTION OF MAN.—In *Scientia* for October, Prof. Mendes-Corrêa discusses the factors which must be taken into account in studying the question of the dispersion of early man over the earth. It must be remembered that early man, although man is the most widely distributed of the primates to-day, did not possess the mobility of modern man or his cosmopolitan character. His nomadism was restricted. The sea was a formidable obstacle, as it still is to-day to many coastal or insular peoples. In the earliest times geographical conditions 'canalised' migrations and man was the slave of his environment, though gradually he came to react on it. Present ethnical distribution is no sure guide, and the continuity of occupation in any given area must be traced equally with the changes in an environment which may have modified its suitability for occupation. Further, in framing generalisations for large areas, local variations must not be overlooked, as for example in the clearings of equatorial forests and the oases of desert areas. Yet even so, geographical factors are not alone to be taken into account. Safety, the surroundings, adaptability for exploitation, social and political organisation, and the like must be considered. Turning to the place of origin of man, palæolithic man lived in Asia, as a number of discoveries show, the Siwalik Hills have produced fossil remains of early apes, a Neanderthal skull has been found in Palestine, and the peoples of to-day include a number of very primitive types. On the other hand, Africa has a palæolithic industry, remains of primitive types of early apes and man and the chimpanzee and gorilla. Yet again all around the Indian Ocean and its archipelagoes are found localised groups of inferior types which require consideration. The negritoes of Malaya and the Australians may be early immigrants, and in addition there are Pithecanthropus from Java and Wadjak man. Discoveries in the Fayum, in the Siwalik Hills, and South Africa might point to a peripheral distribution of both anthropoids and Catarrhine apes of which the lemuroids of Madagascar might form part. The area of the Indian Ocean might thus appear to have been a centre of dispersion.

FIJIAN ROUND BARROWS.—In *Man* for October, Mr. A. M. Hocart corrects an inaccuracy in Williams's account of Fiji which has been brought to light by the use of a woodcut from that author's work as evidence of the existence of round barrows in Fiji. As a result of inquiry, Mr. Hocart has ascertained that Nautuutu, the barrow in question, was undoubtedly square. He has, however, now discovered among his own notes a record of a round barrow at Namoka on Vanua Levu which he had overlooked. He also observed a square mound at Nambuna and an oblong mound in Scanganga, so that three forms were found together. According to the native account, the temple was round, with one door and with pointed apex. It was built of the same materials as a house but ornamented. It was not built on the top of the mound, but the mound was inside it. This mound was the holy land on which no one might tread. In Ceylon there was, and still is, a custom of building a temple not on, but over the smaller topes. The author has already traced the tee of a Buddhist tope to a square shrine built on the tumulus. It is suggested that the house on the tumulus has petrified in a process of conventionalisation and its meaning been forgotten, and that another house has been erected on the whole. In Fiji this process has not taken place, and the house over the mound is not a reduplication but an alternative, which may have existed before the separation of the Indian and Fijian round barrows.

NORTHERN TINTINNIDS. — Dr. E. Jörgensen of Bergen gives an excellent account of the Tintinnidæ in the North Sea and Baltic ("Die Tierwelt der Nord- und Ostsee," Lieferung 8, Teil II. c: Tintinnidæ. Leipzig: Akademische Verlagsgesellschaft, 1927.) This group is little known except to plankton workers, and these know it better than any of the other Infusoria, as it contains the commonest and most easily recognisable plankton forms, both neritic and oceanic. A tintinnid lives in a beautifully formed vase-shaped case or house, which remains intact after the death of the animal forming and inhabiting it. These cases are used as the basis of classification of the various genera, fifteen being recorded from this area; Tintinnopsis, the best-known genus, having ten species, the case being covered with extraneous particles such as sand grains and coccoliths. Other genera may have a perfectly smooth and hyaline case and some may be ringed spirally at the open end showing growth lines, others having regularly pierced cases like basket-work. The method of formation and structure of these cases is extremely complicated and difficult to elucidate. Inside the case the infusorian is fixed by a thread-like portion of the body, either at the bottom or the side: only very exceptionally is it loose. When actively swimming, the broad end, armed with ciliated plates, projects from the case and, presumably, as it swims sweeps into the body small living creatures on which it feeds—flagellates, dinoflagellates, and diatoms. No worker knows the group better than Dr. Jörgensen, and the present survey is exceptionally welcome and useful to planktologists, as the Tintinnidæ in "Nordisches Plankton," the sister publication of "Die Tierwelt," has not yet appeared.

SEX-LIMITED HORNS IN CATTLE.—From the experience of cattle breeders it has long been known that in the domestic breeds the polled or hornless condition usually behaves as a simple dominant to the horned condition. Exceptional cases are now being recorded, however, in which horns are a sex-limited character in crosses, being generally present in males and absent in females. Such cases are recorded by Mr. A. D. Buchanan Smith (*Jour. of Genetics*, vol. 18, No. 3) in crosses between native-horned cows in Rhodesia and Aberdeen-Angus polled bulls. The heifers produced were all polled, and the bulls nearly all had horns. Among the wild white park cattle of Britain there are horned and hornless herds, the Chillingham and Cadzow herds being horned, while several other herds are polled. Matings of horned with polled in these herds give an abnormally small number of polled calves, so that here also factors are present which modify the ordinary recessiveness of horns. Other records of a similar kind are cited, and the statement of Prof. Cossar Ewart is quoted, that several species of cattle with horned males and hornless females occur in the lower Pliocene. This older condition appears to have persisted in some strains down to the present time. That such sex-limited inheritance may occur in a modern herd is indicated by a short record (Mr. O. O. Churchill, in *Jour. of Heredity*, vol. 18, No. 6) of a registered herd of Hereford cattle in North Dakota, in which matings between horned bulls and polled cows produced polled heifers and bull calves with horns or scurs. Future studies will throw light on the nature of the difference between

simple recessiveness and sex-linked inheritance of horns. That cattle were originally hornless is clear from the Pliocene records of Leptobos species without horns. Mr. R. C. M. Auld (*Jour. of Heredity*, vol. 18, No. 7) gives a number of illustrations and records showing that the polled condition has persisted through historical time. Polled cattle existed in Egypt, 2150 B.C., they are shown on coins from Mytilene in the fifth century B.C. and in prehistoric Pictish carvings in Scotland. Palæolithic drawings of polled cattle, probably domesticated, are found in a French cave of the Madeleine period. The original hornless type thus gave rise to a horned race in which the horns were at first confined to the males. Horns are not considered an advantage in fighting between males, but their possession is useful in driving off carnivorous enemies. Whether they arose as a single mutation or in some other way, their origin would appear to have been a relatively sudden development.

TERTIARY MOLLUSCA OF JAPAN.—Reference has previously been made in these pages (NATURE, Sept. 11, 1926, p. 389, and Dec. 4, 1926, p. 819) to the important papers by Prof. Matajiro Yokoyama on the Tertiary Mollusca of Japan. A further series of six papers by the same author has just arrived (*Jour. Fac. Sci. Imp. Univ. Tokyo*, sect. II., vol. 1). The collections now dealt with come from the province of Tosa, in the island of Shikoku or Nanka, and on the main island from the Atsumi peninsula and southern Tôtômi, the neighbourhood of Tokyo, and western Shimôsa and southern Musashi, as well as the oil-fields of Akita in the province of Ugo. The same method is adopted as before in each paper: a brief but clear introduction discussing the topography and geology of the area in question, with a list of the fossils, is followed by descriptions of the species and illustrative plates. In two cases useful indexes are appended. Taken together, these papers total 145 pages with 15 plates. With regard to the fauna of the Musashino beds (Pliocene) the author points out that it is more northern than that of the recent adjacent seas. A few of the species present are also found in the English Crags. There is inevitably a large number of new species.

THE ADELAIDE DISTRICT, SOUTH AUSTRALIA.—A paper read at the Royal Society of South Australia on Sept. 8, by Dr. C. Fenner, described the geographical development of the Adelaide district, South Australia. It was, in the Middle Kainozoic, a wide well-timbered plain of ancient rocks, with meandering streams, broad swamps, and a warm temperate climate. This plain sank below sea-level, and the submergence lasted throughout the Miocene and part of the Pliocene, after which it was slowly uplifted as a low-level limestone plain. About the beginning of the Pleistocene were formed two great semi-circular sunklands bounded to the east by the Mount Lofty and Flinders Ranges. The lowest parts of the sunklands were occupied by Lake Torrens and the Spencer-Vincent Gulfs. The Mount Lofty Highlands were covered with Miocene limestone; but this cover has been mainly stripped off by river action, which also carved out deep valleys and covered the lowlands with alluvial material. The gorge of the Torrens River is attributed to the Pleistocene, and the upper valleys to possibly the late Pliocene. The country was colonised about a century ago, but its development was hampered by the mountain barrier between the Adelaide plains and the Murray Valley. The rate of growth of progress of the population has recently been greatly accelerated, and if the present rate continues until 1940 the population would amount to 450,000. By 90 years growth it has reached 320,000. Adelaide is now the chief market and port of the State of South Australia, and is a rich garden owing to the conjunction of favourable climatic conditions, city site, and general amenities.

MOUNTAINS OF NORTH-EASTERN SIBERIA.—During last year a series of important geographical discoveries were made by S. V. Obruchev during the course of his exploration of the little-known region traversed by the Indigirka and Kolyma Rivers. A very considerable mountain system was found trending across the upper Indigirka, reaching heights of 3000-3300 metres in places. A preliminary report appears in the *Zeitschrift für Gletscherkunde* of July, 1927. Although no glaciers were seen, the mountains were found to be capped with perpetual snow, and the landscapes and surface deposits clearly indicated very extensive glaciation in the past. Mountain ranges to the east and west have already been mapped, and altogether a system 1000 km. in length and roughly 300 km. across is now known, forming an arc concentric with the previously known outer arc of Verkhoyansk-Anadyrsk. From the point of view of Asiatic tectonics and the former glaciation of Siberia, Obruchev's work is of fundamental value, and further details will be eagerly awaited.

THE GEOLOGY OF THE SPRINGBOK FLATS.—A memoir of more than usual interest on the north-eastern part of the Springbok Flats has just been published by the Geological Survey of South Africa (Explanation of Sheet 17, 1927, by Dr. Percy A. Wagner). Points of particular importance are the descriptions of the Rooiberg beds (Transvaal system) and their associated keratophyres and nodular felsites; the marble formations of the Dolomite series; the igneous rocks of the Bushveld complex; the local development of the Karoo system and the Stormberg volcanics; and the general physiography of the 'Flats'. Interesting evidence of climatic changes is presented. There is clear proof of an epoch of (*a*) vigorous erosion succeeded by (*b*) an arid period which led to the aggradation of the valleys with silt; and finally (*c*) renewed vigorous erosion in which the present streams have cut down to the coarse gravel or bedrock with which the valleys are floored. The rejuvenation is not due to a steepening of grade, but to an increase of rainfall; and Roger's contention that there is no ground for the common opinion that South Africa is drying up thus receives strong support.

MAGNETIC OBSERVATIONS IN THE NORTH.—The Danish Meteorological Institute has initiated a new series of occasional publications (in octavo form) entitled *Communications Magnétiques*. The first two issues, lately published, contain five interesting papers, of which the most noteworthy is perhaps that written by the Director, Dr. La Cour, "on the mean error of the monthly means of the magnetic elements observed at the observatory of Rude Shov." This able and valuable paper consists of a comparison of the apparent changes in the monthly means obtained at eleven European observatories during 1911–1920, and throws light on the probable freedom (or otherwise) from small systematic errors in the absolute magnetic observations at these stations. Another paper describes the novel and apparently satisfactory method of direct determination of scale values for the magnetographs of the recently instituted Danish observatory at Godhavn, Greenland; the daily variations of the elements are so great that the scale values can be measured by taking absolute observations at different times of the day. The other three papers deal with the heating of the upper

atmosphere by cathodic rays (connected with auroræ) from the sun; and with the values of the magnetic elements at Rude Skov during the recent eclipse, and during a still more recent magnetic storm—of July 22, 1927.

TIDAL RESEARCH.—The eighth annual report of the Tidal Institute of the University of Liverpool indicates a steady growth in the work of tidal analysis and prediction executed by the Institute for the Admiralty and various port and harbour boards in Great Britain, and for the Hydrographic Offices of Canada and China. The methods of computation have been further improved and simplified. Various improvements have also been made in the tide-predicting machine of the Institute; one of these, the fitting of ball-bearings for the pulleys, has reduced the friction and practically eliminated the small elastic variations in the length of the tape which had been found due to friction at the pulley-bearings. The director, Prof. Proudman, and the secretary, Dr. Doodson, have continued their studies on the dynamical theory of tides.

X-RAY TUBE RADIATION.—In the issue of the *Physikalische Zeitschrift* for Sept. 15, Drs. D. Nasledow and P. Scharawsky, of the Röntgen Institute, Kiev, sum up their conclusions as to the variation of the intensities of the characteristic lines and of the whole radiation from X-ray tubes with the current through the tube. The intensity of radiation is measured by the current transmitted through a tube containing air ionised by the radiation under the action of a constant electromotive force sufficient to produce the saturation current. Anticathodes of copper, molybdenum, palladium, silver, and tungsten have been investigated, and all give for currents of a few milliamperes through the tube, intensities of radiation proportional to the current, up to a critical value which increases with the atomic weight of the metal from 4 to 8 milliamperes, after which the increase of the intensity is proportional to the increase of the current. The change of slope of the intensity—current graph at the critical point increases as the electromotive force on the tube increases.

THE ELECTRONIC STRUCTURE OF ATOMS AND THE PERIODIC CLASSIFICATION.—The relation between atomic structure and the periodic classification is discussed in a preliminary paper by J. D. Smith Main in the *Journal of the Chemical Society* for September. A classification is put forward which facilitates the interpretation of atomic structures without suppressing the chemical importance of the usual eight valency groups. Instead of expanding the groups in the periodic table, as has usually been done when the mathematical interpretation of atomic structure has been the chief interest, the author considers that the chemical properties are best brought out by its abridgment. This involves the relegation of a considerable number of elements in the long periods to the position of 'transitional elements.' Elements in the abridged periods are regarded as having valencies which vary only in multiples of two, difficult exceptions being otherwise explained. Eight groups are thus found, divided into an 'alkaline' group, an 'amphoteric' group, and a 'non-basic' group, the valencies running in units from 1 to 7 and then falling to zero, or else, in each group, differing by 2, 4, or 6. Two extra tables of transitional elements are then required, one containing the rare earth elements. The complete table is then formed by combining these sets of elements. This complete table differs only slightly from the usual table in appearance, but the so-called 'transitional' elements are now distributed in the body of the table as well as occurring in Group VIII. The rare earth elements must form a 'footnote' to the table.

CO-ORDINATION COMPOUNDS OF QUINQUEVALENT MOLYBDENUM.—The September issue of the *Journal of the Chemical Society* contains an account of a study of salts of the types $R_2[MoOCl_5]$, $R[MoOCl_4, H_2O]$ and $[MoO_2X_2, 2H_2O]R$. One of the most interesting features of certain of these salts is the large number of ions produced when they are dissolved in water, the various stages of ionisation being accompanied by distinct colour changes. At infinite dilution, the complex salts $R_2[MoOCl_5]$ yield ten ions and consequently have very high molecular conductivities. Several new salts have been prepared.

GRAIN GROWTH IN COMPRESSED TUNGSTEN POWDER.—The only systematic examination hitherto on this subject is that due to Sauerwald, who considered that grain growth occurred at the same temperature of 2500°-2700° C. irrespective of the method of preparation of the powder or the pressure. Smithells, Pitkin, and Avery, in a paper presented at the September meeting at Derby of the Institute of Metals, have re-examined the subject. From determinations of the electrical energy required to heat the powder, the density and the microscopic condition of the product, they have shown that the temperature of sintering is a function both of grain size and of the pressure used in forming the bar. Using powders the mean particle size of which varied from 0·6 μ to 3·5 μ and pressures from 8 to 32 tons per sq. in., the temperature at which grain growth could first be detected varied from 1100° to 1500° K. The finer the powder and the greater the pressure the lower was the temperature necessary for growth. It is known that if the hydrogen atmosphere in which the tungsten is heated contains even a trace of moisture, the structures obtained are greatly affected. In this work the greatest care was used in drying the gas, but the oxide originally present in the powder may have influenced the changes observed.

THE SOLUBILITY OF CEMENTITE IN α-IRON.—The extent to which carbon is soluble in α-iron, though admittedly it cannot be large, has not yet been satisfactorily settled. A paper by J. H. Whiteley to the recent Glasgow meeting of the Iron and Steel Institute carries the matter somewhat further and shows that there is a marked increase in this solubility as the temperature is raised, and at 720° C. the solubility is about 0·03 per cent. At 630° C. it is still appreciable and the carbide may be retained in solution in the iron by rapid cooling. The quenched material on tempering precipitates carbide at or below 250° C., and as the temperature of tempering is raised the minute globules thus formed travel to the crystal boundaries. The velocity of this migration increases with temperature, and at 550° C. is very great. By quenching below the AcI point, sufficient carbide is retained in solution by the iron as compared with that in a slowly cooled sample appreciably to increase the Brinell hardness. During slow cooling the carbide is thrown out of solution on the existing particles and the inference is drawn that slowly cooled ferrite in ordinary steels contains little if any carbon in solid solution. This is in accord with the conclusions of Yamada and Yensen, who place the solubility limit at less than 0·01 per cent. As the purity of the iron is reduced by the presence of other elements in solid solution, the solubility of carbide in the α-ferrite is in all probability correspondingly reduced and the temperature at which the solubility commences to increase rapidly is somewhat raised.

Draft Statutes for the University of London.

WE published on July 10, 1926, a leading article on the reconstitution of the University of London. The position at that time was that the Government had redeemed its pledge to introduce legislation "to make further provision for the University of London" by introducing a Bill in the House of Lords, and this Bill had been accorded its second reading on the motion of the Earl of Balfour. On Nov. 19, the Bill received its second reading in the House of Commons on the motion of Lord Eustace Percy, president of the Board of Education, in a conciliatory and closely-reasoned speech. Dr. Graham Little, the member for the University, led the opposition in a vigorous speech, urging that any necessary changes in the constitution of the University should be made by those having internal knowledge of its work and aspirations. "It is in the interests of freedom," he said in his peroration, "the freedom of the University and the freedom of the students, especially of external students, that I beg the House to reject the Bill." Capt. Fairfax, who seconded the rejection, was supported by Sir Richard Barnett; but most of the speakers, including Mr. Trevelyan, Mr. Withers, Sir Alfred Hopkinson, Mr. Lees Smith, Mr. Hilton Young, accepted the main principles of the Bill, which passed its second reading without a division. The proceedings in Standing Committee on Dec. 2 produced two important Government amendments, the first safeguarding the interests of theological colleges whose position is differentiated from that of other colleges in their not receiving financial support from the Government; and the second, in the form of new clause—a concession implementing the Government's declaration that there was no desire or intention to establish State control of the University—authorising recommendations to His Majesty in Council from persons or bodies representative of the University regarding the appointment of the crown members of the council of the University. The Bill received the Royal Assent on Dec. 15, and its short title is "University of London Act, 1926."

The chief purpose of the Act, in accord with precedents recently adopted for Oxford and Cambridge, and followed also for London in the earlier re-constitution under the Act of 1898, is to appoint commissioners to draft new statutes for the University. Mr. Justice Tomlin is chairman, and the other commissioners are Sir Amherst Selby-Bigge, Sir Cyril Cobb, Sir Josiah Stamp, Sir Cooper Perry, Dr. A. D. Lindsay, Miss Bertha Phillpotts, and Prof. T. P. Nunn. Sir Henry Sharp has been appointed secretary. The duty of the commissioners is to make statutes for the University "in general accordance with the recommendations" of the Departmental Committee of the Board of Education, appointed by Mr. Trevelyan in 1924 "subject to any modifications which may appear to them to be expedient." The first draft of the proposed statutes has been published by the commissioners, who invite representations thereon pursuant of sub-section (2) of section 4 of the Act.

Under section 21 of the draft statutes, a "Council of the University" is to be appointed of 16 members with power "to determine finally any question of finance arising out of the administration of the University or the execution of its policy, or in the execution of any trust requiring execution by the University." Its members are the chancellor, vice-chancellor, and chairman of convocation *ex officio*, six members of the senate appointed by the senate, four by His Majesty in Council, two by the London County Council, and one co-opted member.

Under clause 39, the senate is to consist of 50 (or possibly 51) members, namely, the chancellor, the vice-chancellor, the chairman of convocation, and the principal *ex officio*, 16 by convocation to be elected by the graduates according to faculties, 16 by the faculties composed of teachers of the University, 11 by colleges and medical schools, and 4 co-opted members. The colleges which are to be granted direct representation are: University, King's, Bedford, Birkbeck, East London, Imperial, London School of Economics, Royal Holloway, and Westfield (the last two have been added to the list published in the report of the Departmental Committee), and two representatives of the general medical schools to be elected by a meeting of the deans of such schools. The senate is to be "the supreme governing and executive body of the University in all academic matters." The vice-chancellor need not on election be a member of the senate, and if he is not, the total membership of the senate will be increased to 51.

There are to be five standing committees of the senate, namely, the academic board, the board for external students, the collegiate board, the university extension and tutorial classes board, the matriculation and schools examination board. The academic board is to include, in addition to the 16 faculty members of the senate, 9 other persons appointed by the senate. The principal is to be chairman of the collegiate board, to be composed of college principals and to be responsible largely for the co-ordination of the teaching work of the University. No important change has been introduced into the organisation of faculties and boards of studies, but the regulations governing the admission of schools to the University are to be made more stringent. New schools, other than theological colleges, will be prohibited from applying for or receiving any money from any public body otherwise than through the council of the University, and will not be allowed, except with the consent of the council, to appeal publicly for money or accept any benefaction to which any onerous condition is attached.

Under the existing statutes based on the Act of 1898 the senate is "the supreme governing and executive body of the University." Apart from the powers to be assigned under the new statutes to the council, the senate under the new statutes (Draft Statute 48) "may delegate or authorise the delegation of any of their powers to any standing committee of the senate or to any subordinate committee or body."

The appointed area for the admission of new schools is the administrative County of London, including the County of the City of London. But teachers of the University may be recognised in institutions situated in this area or in Middlesex, Surrey, Kent, Sussex, Essex, or Hertfordshire. Also the senate may admit as a school of the University any public educational institution situate outside the County of London which is wholly or mainly devoted to the pursuit of some branch of University study, which cannot, in the opinion of the senate, be adequately pursued in any institution within the London area or for which no recognised teacher or adequate body of recognised teachers is available in the larger area for such recognition (Draft Statute 106).

Under clause 134, a new power is to be given to the senate to "revoke any degree, diploma, certificate, or distinction conferred by the University, and all privileges connected therewith, if the holder shall have been convicted in a court of law of felony or of

any misdemeanour which, in the opinion of the senate, by reason of its immoral, scandalous, or disgraceful nature, renders him unfit to hold any such degree, diploma, certificate, or distinction"; and on good cause shown to restore the same degree, diploma, certificate, or distinction, without further examination.

Special college examinations, both at the intermediate and final stages, are authorised by draft statute 137.

A list of schools of the University "immediately prior to the appointed day" is printed as a schedule.

The office of the commissioners is 5 Clement's Inn, W.C.2.

The Gibraltar Skull.

AT a meeting of the Royal Anthropological Institute held on Tuesday, Nov. 1, Mr. H. J. E. Peake, president, in the chair, Miss Dorothy Garrod described the excavations at the Devil's Tower, Gibraltar, in which she had discovered the skull now known to be a relic of Neanderthal man. Mr. L. H. Dudley Buxton gave a description of the skull, and Prof. G. Elliot Smith described the endocranial cast, from which it has been possible to observe the main features of the conformation of the brain.

Miss Garrod gave an account of the excavations in the spring of 1926 in the cave, which was first observed by the Abbé Breuil during the War when excavation was impossible. The portion of the skull first discovered was found embedded in hard travertine, from which it was blasted with dynamite. The fragments were near one another but not contiguous. In the autumn, excavations were resumed, and the cave and talus were cleared down to bed rock, where further fragments of the skull, including part of the lower mandible, were discovered. The associated remains of fauna indicated that the skull was of Pleistocene age. The differences in the species represented here and those from other sites of the same period are attributed to the warmer climate. They are characteristic of the Spanish Pleistocene age. All the implements discovered in the different strata were of Upper Mousterian type. The cave had apparently been used as a place of habitation, but probably only at certain seasons of the year.

Mr. Buxton said the human remains discovered by Miss Garrod in her excavations include the following bones of a human skull: the frontal, the left parietal, the right half of the maxilla, the right temporal, the greater part of the lower mandible, and four milk teeth, two molars being still in their places in the upper and lower jaws respectively, unfortunately not on the same side.

Although there are certain gaps which make reconstruction a matter of considerable difficulty, there is no reasonable doubt that the bones belong to the same individual, as many of the pieces fit together, and those which do not, that is, the temporal and the parietal, can be shown to belong to the same skull by duplicating the bones, so that a left temporal is made to fill up the gap on one side and a right parietal the gap on the other.

Apart from other details, the age is best indicated by the teeth. The first permanent molars were never erupted, but were nearly ready to erupt. It is therefore reasonable to put the age at between the fifth and sixth years, as the permanent molars erupt in the latter year. This is merely an indication, as we have no evidence that the teeth of Neanderthal man erupted exactly at the same time as those of modern man. It seems probable from the size and general characters that the sex was male, and that the La Quina child was therefore female.

Although, no doubt owing to the age of the specimen, the brow ridges have not yet attained that development which is so marked a feature in Neanderthal man, the remains certainly belong to a member of that branch of the human family. Apart from details the most striking characters are the low flattened form of the vault and the form of the massive jaw. The teeth when viewed by X-rays show the 'taurodont' appearance, both in the deciduous and unerupted permanent teeth, which is not the least of the characteristic features of Neanderthal man.

Prof. Elliot Smith said Miss Garrod has made it clear that the fossilised skull fragments found by her can be referred with certainty to the Upper Mousterian phase of culture; and Mr. Dudley Buxton has shown that they formed a part of a five-year-old child who conformed to the Neanderthal type. Hence it is a matter of some interest to discover in the endocranial cast features that sharply differentiate it from those of all other known representatives of the Neanderthal species. There is a fullness of the prefrontal and parietal areas such as is unknown except in *Homo sapiens*. Yet the general form of the cast conforms to the Neanderthal type.

The question naturally arises whether this apparently exceptional development of the brain may not be due to some pathological condition, such as hydrocephalus, causing a general expansion of the cerebral hemispheres. While the possibility of hydrocephalus cannot be wholly excluded, there are reasons for regarding such an explanation of the condition as improbable. The excavations upon the inner table of the cranium that correspond to the convolutions are exceptionally distinct for a young child's skull, and the ridges that separate them are too salient to be reconciled with an hypothesis of hydrocephalus.

Hence it appears that the unexpected form can be accepted as definite evidence of an altogether exceptional development of the prefrontal and parietal areas for a member of the Neanderthal species. In Neanderthal man the most obtrusive feature of the endocranial cast, as Anthony and Boule have emphasised, is the small size of the prefrontal area. But the series of Neanderthal crania that are now available for study reveal a considerable range of variation in the size of the frontal territory. Admitting that the Devil's Tower skull differs from the rest in an exceptional expansion of those areas of the brain which confer upon *Homo sapiens* his most distinctive attribute, it must not be assumed that the Gibraltar child represents a link between the two species. It is definitely Neanderthaloid and must have acquired its peculiar cerebral characters independently of *Homo sapiens* by convergent development. Nor must the condition be regarded as a normal precocity of the Neanderthal child that afterwards atrophies. The child's skull found at La Quina in 1921 by Dr. Henri Martin conforms in every respect to the adult Neanderthal type. Particular emphasis is laid in Dr. Martin's and Prof. Anthony's reports upon the defective development of the frontal region.

The peculiar form of the Devil's Tower skull is, however, influenced to some extent by the age of the child, for it presents a certain analogy to the peculiarities often found in the five-year-old child of *Homo sapiens*. The chief interest of the endocranial cast of the Devil's Tower skull is the demonstration it affords that Neanderthal man reveals indications of possibilities in cerebral development formerly supposed to be the exclusive privilege of *Homo sapiens*.

Structure and Formation of Colloidal Particles.

THE joint discussion between the Sections of Physics and Chemistry held on Sept. 2 at the meeting of the British Association at Leeds on the subject of the structure of colloidal particles, directed attention to the remarkable progress which has been made in recent years in the elucidation of the texture of disperse systems.

Both Sir William Bragg, who presided, and also Dr. Freundlich laid emphasis on the importance of the method of examination by means of X-rays as well as on the limitations of the method. If the particles of a colloid are crystalline but not orientated in any specific direction, such as in gold and silver sols dispersed in water, a characteristic line photograph is obtained, whilst in addition, if the particles are orientated round an axis, as is the case in certain fibres, a spot pattern photograph is obtained. In many cases it is found that the broad diffuse rings indicating an amorphous character are replaced by the line photograph of the crystalline material as the suspension grows older, and we thus obtain a convenient method for determining the velocity of crystallisation of these substances.

When X-ray photographs are taken of liquids, it is found that in certain liquids, for example, cyclohexane, the rings are much more distinct and sharply bounded than in others; similarly, in the photographs taken of iron, prepared for the synthesis of ammonia by the catalytic method, both broad and thin rings can be obtained dependent on the method of preparation and the period of sintering. It is clear that we are dealing with materials which have a tendency to orientate themselves to form crystal nuclei.

It is somewhat unfortunate that the measurement of the breadth and intensity of the lines alone does not allow us to distinguish between two effects, whether the change in line breadth and intensity is associated with a change in the size of the micro crystals or a growth in the number of orientated particles. At the present time a method of distinguishing between these two factors is a matter of some importance.

Whilst the X-ray method alone gives no definite clue to the shape of the particle, it does at least give some indication of the processes by which crystals grow more readily in certain directions than in others; thus, the lamellar or flake-like character of large crystals of the fatty acids is readily anticipated from the crystal form determined by this method. Since, however, the shape of the particles is defined by magnitudes although submicroscopic yet greater than molecular in size, we may obtain information on this point by optical methods. A distinction between spherical and non-spherical particles can readily be made by observance of the scintillations in the ultra microscope or the double refraction of light in sols streaming through a channel, and even by the light absorption of colloidal solutions; thus, many sols, such as arsenious trisulphide and non-stretched gelatine, are found to be spherical.

The optical behaviour of streaming sols in a Tyndall beam gives some indication of the shape of the particles when these are not spherical; thus, it is possible to distinguish between attenuated string- or rod-like particles in contrast to those plate-like or lamellar in form. The optical evidence for the rod-like structure of the colloidal particles of sols such as benzopurpurin or vanadium pentoxide is again supported by the shape of the macro crystals of these materials grown in the ordinary way. It is, indeed, stated in the literature that benzopurpurin crystals can be grown so long and slender that they will pass through the pores in a filter paper in their end-on position, and that the crystals themselves are in continuous flexion under the influence of the Brownian agitation.

It is somewhat remarkable that the crystals of silver sols, which from their crystal growth one might reasonably anticipate to be either octahedral or possibly cubic in form, actually appear to deviate from the regular structure towards a lamellar form.

Such optical methods provide weapons with which the problem of the mechanism of formation of colloidal particles can be attacked. Von Weimarn's well-known criterion of the magnitude of the dispersion coefficient permits the prediction of the form of an insoluble product formed by interaction of two soluble salts. In cases where the dispersion coefficient is high, colloidal solutions or even gels may be obtained; the individual particle size is partly determined by the dispersion coefficient and the growth rate may be termed, with Haber, the grouping velocity. The clusters or aggregates of molecules thus formed at haphazard must, in order to become a crystalline assemblage, become orientated in their space lattices. This action may proceed at various rates; the velocity of orientation may be, and frequently is, very different from the grouping velocity.

It is thus possible to prepare numerous colloids, both in the crystalline as well as the amorphous state, by suitable adjustment of these two velocities. By rapid condensation of silver vapour admixed with naphthalene at liquid air temperature, for example, the preparation of colloidal amorphous silver can be effected, whilst under the ordinary conditions for preparing both colloidal silver or gold, the particles are completely crystalline, an indication that the velocity of orientation is extremely high.

These changes from the amorphous to the crystalline in solid substances can thus take place at different rates and are at least to a certain extent under control; that mechanical effects, such as stretching or pressure, effect orientation of the cell units in substances as varied as rubber, gelatine, and waxes, is definitely revealed by X-ray examination. An equally complex but interesting field for study is the structure of aerosols or smokes. As was pointed out by Prof. Whytlaw-Gray, the study of smokes is rendered more difficult by the fact that smokes are unstable and continue to undergo processes of aggregation and precipitation. Nevertheless, from photomicrographs it is possible to recognise definite crystal structure in many of such aggregates: in others the smoke particles appear as small spheres. It is at present a matter of interesting speculation whether the conceptions of von Weimarn and Haber on the conditions of formation of particles in solutions are not applicable in this field also.

It is frequently argued that problems such as the shape or form of colloid particles may be a matter of deep scientific interest, but that the industrial chemist is satisfied provided that his suspension or smoke fulfils certain standard arbitrary tests, for example, grain size. A brief consideration of the relatively great covering powers of plate-like particles in paints and glazes, or the factors governing the adhesion of fungicides, to mention but two cases, shows that the discussion held at Leeds was full of import to numerous industries.

ERIC K. RIDEAL.

University and Educational Intelligence.

CAMBRIDGE.—Prof. A. S. Eddington has been elected as a member of the Council of the Senate. Mr. F. H. Garner has been appointed University demonstrator in agriculture.

The annual report of the Board of Research Studies makes interesting reading. There have been 72 degrees of Ph.D. awarded during the year, 5 of M.Sc., and 6 of M.Litt. A third of the 272 resident research students are now graduates of Cambridge; the other English universities send 37 research students, the United States 31, Scotland 21, Australia 17, Wales 16, Canada 12, and South Africa 10. As to subjects, chemistry has 42 students, physics 35, mathematics 25, English 21, history 20, while divinity, geography, fine arts, metallurgy, and moral science claim but one student each. Trinity has now a strong lead in the number of research students with 46, followed by Emmanuel, 37; Caius, 25; and Newnham, 21; at the other end of the list are Peterhouse, 3; Pembroke, 2; Jesus, 2; and Selwyn, 3.

MANCHESTER.—Mr. T. H. Osgood has been appointed an assistant lecturer in physics.

The Council has appointed Prof. A. H. Gibson to represent the University at the celebration of the centenary of the Institution of Civil Engineers.

The following awards have been made: Grisedale biological scholarship in botany to Frances L. Stephens; William Kirtley senior scholarship in engineering to Frank Roberts.

THE degree of doctor *honoris causa* of the University of Paris has been conferred on Sir Frederic Kenyon, Director of the British Museum, and Prof. J. S. E. Townsend, Wykeham professor of physics in the University of Oxford.

THE third annual report, for 1926–27, of the London School of Hygiene and Tropical Medicine, was presented to the Court of Governors, which met on Oct. 31. The Director, Dr. Andrew Balfour, reported on the work of the Tropical Division, and stated that the advantages of the twenty weeks' course of study in tropical medicine and hygiene, as compared with the shorter course, have now been definitely established. A Division of Medical Zoology has been constituted for administrative purposes, comprising the three Departments of Entomology, Helminthology, and Protozoology, with Prof. R. T. Leiper as its head. The organisation of the Museum continues to make steady progress under the immediate direction of Major-General Sir Wilfred Beveridge. Prof. W. W. C. Topley has been appointed to the chair of bacteriology and immunology, and is conducting a course of instruction for the newly instituted Diploma in Bacteriology of the University of London. The construction of the new building for the School, delayed by the coal dispute of last year, is now making substantial progress. The provision of clinical and pathological facilities for the study of tropical diseases has been considered by a committee, which recommends the establishment, adjacent to the School, of a hospital with 150 beds, for which a capital sum of £250,000 would be necessary. The financial account for the year shows an unexpended balance of £1452. The Trustees of the Rockefeller Foundation have now transmitted the whole amount of their original gift of two million dollars, which has been converted into sterling at a favourable rate. The University Grants Committee has notified that the grant of £7200 for 1926–27 has been increased, with the consent of the Treasury, to £18,000 for the new year.

AN address on the future of technical education was delivered by the President of the Board of Education on Oct. 19 at the Wigan Mining and Technical College. Two points were specially emphasised: the importance of guidance in the shape of specifications deliberately formulated by industrialists of what kinds of skill they wish to find in the recruits they are to draw from the technical schools, and the importance of increasing the day classes, which at present have very few pupils compared with the evening classes. As regards the first point, such specifications should provide for technical education the same kind of help as the secondary schools and universities receive, and have, for generations past, received from the professions. Much attention has been given to this matter during the past two years in the United States, where more than six hundred 'job specifications' were drawn up a year ago by twenty-five of the largest industrial concerns in the country. Lord Eustace Percy hopes that with increasing definiteness of aim, technical education will be susceptible of more effective advertisement than is possible at present and will, in consequence, obtain more support. He attaches much importance to this task of "making a more or less clear picture out of the kaleidoscope of technical education." Referring to the need of more day classes, he pointed out that whereas about ninety per cent. of all our technical education is conducted in evening classes, about eighty per cent. in Prussia is in classes which do not meet after eight o'clock in the evening. In Germany likewise, employers of labour commonly make attendance by their employees at day classes obligatory.

IN the course of a recent discussion of "Technical and Non-technical Management" by the British Section of the Société des Ingénieurs Civils de France, an interesting account of technical education in France was contributed by Mr. Androuin and the reader of the paper, Mr. Lucien A. Legros. It would appear that a great deal of attention is being devoted to the improvement of apprenticeship. Certain works, such as those of Panhard and Levassor, make special arrangements for the training of their apprentices, for which purpose the older employees are engaged in providing an intensive training in pattern making, machining, and fitting. The value of the instruction is increased since the work performed is on parts which are actually required in the factory in small quantities. Technical instruction in France is given in public, national, and municipal schools. Private schools work in association with, or model themselves on, the State schools, and if efficient they are assisted by the Ministerial Department of Technical Education, which is said to be one of the best managed of State institutions. In all the schools the aim is to provide a thorough groundwork, on which specialised training can afterwards be developed. The Polytechnic, the Schools of Mines, of Bridges and Highways, of Posts and Telegraphs, etc., are very well known and have been founded to supply engineers for the Government services. In addition, there are numerous important technical colleges and specialised schools. In all the industrial schools a certain amount of commercial training is prescribed, while industrial technology is taught in the commercial colleges. In the Écoles des Arts et Métiers, instruction is given in both theory and practice. Third-year students are sometimes made charge-hands over small groups of other students, and this has proved so successful that steps are being taken to extend the practice. Students are also instructed in the making of drawings, and in estimating and preparing cost cards for various parts ordered by manufacturers.

Calendar of Discovery and Invention.

November 13, 1807.—The inaugural meeting of the Geological Society was held at the Freemasons' Tavern, Great Queen Street, on Nov. 13, 1807. Among the eleven gentlemen present were Davy, Babington, Count Bournon, Greenough, William Allen, and Richard Phillips. At this meeting a resolution was passed "That there be forthwith instituted a Geological Society, for the purpose of making geologists acquainted with each other, of stimulating their zeal, of inducing them to adopt one nomenclature, of facilitating the communication of new facts, and of ascertaining what is known of their science, and what remains to be discovered."

November 14, 1894.—Ten years after Sir Charles Parsons patented his steam turbine, the pioneer steam turbine vessel *Turbinia* was constructed on the Tyne, and on Nov. 14, 1894, carried out her preliminary trial. The *Turbinia* was 100 feet long and 44½ tons displacement. Her first engine was a single radial flow turbine giving 960 h.p. at 2400 r.p.m., but this was afterwards replaced by three turbines developing 2000 h.p. and giving the vessel the extraordinary speed of 34½ knots. The after part of the vessel and both sets of machinery have recently been presented to the Science Museum.

November 15, 1850.—In the ring of Saturn, first observed by Galileo, can be distinguished three rings, an outer ring called A, a middle ring B, and an inner ring C. This inner, or dusky ring, some 11,000 miles across, was first distinguished by Bond on Nov. 15, 1850.

November 16, 1492.—In the parish church of Ensisheim in Alsace hangs the oldest known meteorite. Of this a contemporary document says, "On the 16th of November 1492, a singular miracle happened; for between eleven and twelve in the forenoon, with a loud crash of thunder and a prolonged noise, there fell in the town of Ensisheim a stone weighing 260 pounds. . . . It was taken to the church as being a miraculous object."

November 17, 1893.—Heaviside's writings are contained in his "Electrical Papers," covering the period 1872 to 1892, and his "Electro-magnetic Theory" containing his work up to 1912. In the latter is his historic paper of Nov. 17, 1893, in which he laid down the principles of the use of inductance coils in telephone circuits.

November 18, 1846.—Sulphuric ether had been known in the thirteenth century. It was recommended as an inhalant for asthma by Pearson of Birmingham in 1785, and it is said that Faraday in 1818 noted the effects of inhaling it. It was Prof. Jackson of Harvard who suggested to W. T. G. Morton the possibilities of ether as an anæsthetic, and on Oct. 16, 1846, Morton successfully administered it to a patient in the General Hospital of Boston, while the discovery was made known to the world by Dr. Bigelow on Nov. 18, 1846.

November 19, 1787.—"The advance of astronomy in the eighteenth century," wrote Miss Clerke, "ran in general an even and logical course. The age succeeding Newton's had for its special task to demonstrate the universal validity, and trace the complex results of the law of gravitation. The accomplishment of that task occupied just one hundred years. It was virtually brought to a close when Laplace explained to the French Academy, November 19, 1787, the cause of the moon's accelerated motion." With this work, says another writer, "the last anomaly and the last threat of stability thus disappeared from the solar system."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, Nov. 3.—Hans **Spemann** (Croonian Lecture): Organisers in animal development. The conception of 'organisers in development' has been derived from experiments in amphibian embryos in the earliest stages. The different regions of such an embryo have not the same value for development; most of them are relatively indifferent and do not carry their destiny in themselves. This can be shown by transplantation of these parts into other regions of the embryo; they follow the development of their new environments. But there is a certain region in the embryo, parts of which, when transplanted into an indifferent region of the embryo, do not adapt themselves to their new environment, but retain their own character, and force, as it were, the others to follow them. Such parts organise a new embryo, which is built up partly by the transplanted cells, partly by the cells of the host. Therefore they were called 'organisers,' and the region where they lie together in those early stages of development the 'centre of organisation.' Further experiments have been made to determine the extent of this centre, its origin, its intimate structure, and the nature of the organising influence.

PARIS.

Academy of Sciences, Oct. 3.—**Mesnager**: Observations on a note by T. J. de Sèze.—H. **Deslandres**: The law of distribution of magnetic storms and of their elements. Consequences to be deduced regarding the constitution of the sun.—Paul **Helbronner**: The operations of the detailed geometrical description of the French Alps (twenty-third season, 1927).—Paul **Montel**: Subharmonic functions and their relations with convex functions.—Pierre **Humbert**: Spherical prepotential.—L. **d'Azambuja**: The structure of the solar chromosphere.—E. M. **Antoniadi**: The rotation of the third satellite of Jupiter. Observations made on this satellite during the last year with the 83 cm. telescope at Meudon Observatory show that this moon always presents the same face to Jupiter, except for a possible libration in latitude. It is concluded that the period of rotation of the third satellite of Jupiter is equal to that of its revolution round the planet.—G. W. **Ritchey**: Some mechanical and other advantages of the small length and compact structure of the Ritchey-Chrétien type of a planatic telescope.—Jean **Thibaud** and A. **Soltan**: Spectrographic measurements in the intermediate domain (series *K*, *L*, *M*, *N*).—Fred **Vlès**: The optical properties of certain colouring matters susceptible of changing colour in concentrated solutions of neutral salts.—W. **Ipatieff** and B. **Mouromtseff**: The formation of crystallised silicates in aqueous solution under high temperatures and pressures. Silica gel, after heating for 30 to 40 hours at 310°-320° C., under a hydrogen pressure of 200 atmospheres gives hexagonal prisms and pyramids of SiO_2. Replacing hydrogen by carbon dioxide, a crystallised hydrate, 5 SiO_2, 2 H_2O is obtained. The preparation of crystallised silicates of magnesia, calcium, manganese, and zinc is described.—Erling **Botolfsen**: The sublimation of iron in a vacuum. When iron is heated in a high vacuum at 1300° C., below its melting point, it slowly sublimes. In one experiment under these conditions the velocity of sublimation of iron was 0·07 per cent. per hour.—Jean **Cournot** and Macedo Soares **Silva**: The viscosity of nickel, aluminium, and the light alloys.—P. **Lebeau** and A. **Damiens**:

The existence of a compound of fluorine and oxygen (NATURE, Nov. 5, p. 672).—René **Van Aubel**: The genesis of the uraniferous deposits of Kasolo (Katanga). Cubic uraninite is considered to be a pseudomorph. —L. **Picard** and R. **Soyer**: The presence of the Jurassic and of the lower and middle Cretaceous on the western slope of Antiliban.—Jacques **de Lapparent**: The stratigraphical position of the bauxites of the Pays de Fenouillet.—Ch. **Jacob** and L. **Mengaud**: The structure of the massifs of Mont-Perdu, Sestrales, and the Tendeñera in Haut-Aragon.—Henri **Marcelet**: The chemical analysis of the mud collected on the upper terrace of the Musée Océanographique of Monaco, following the storm of Oct. 31, 1926. This brown mud left behind after the storm was free from organic matter, and consisted mainly of silica (46 per cent.), calcium, and magnesium carbonates (36 per cent.), with some alumina and oxide of iron.—R. **Argaud** and G. **Billard**: The lymphoid stages of the digestive tract.—G. **Athanassopoulos**: A somatometric character of Nereus.—M. and Mme. A. **Chauchard**: Cerebral motor localisations in the lower vetebrates.—Alfred **Maubert**: The influence of thorium X on the activity of emulsin. At very low concentrations the total radiation of thorium X has a slight accelerating effect on the reaction between emulsin and amygdaloside; at higher concentrations the activity of the emulsin is reduced and finally destroyed. The accelerating influence is proved to be due to the α-radiation only.—Jean **Feytaud** and René **Dieuzeide**: A parasitic fungus of *Reticulitermes lucifugus*.—A. **Paillot**: Two new Protozoa, parasites of the caterpillars of *Pyrausta nubilalis*.—Edouard **Chatton** and André **Lwoff**: The evolutive cycle of the Infusoria *Fœttingeria actiniarum*. The necessity for a second crustacean host.—Etienne **Wolff**: The behaviour and the rôle of the contractile vacuole of a fresh-water amœba. Experiments are described proving the influence of the osmotic pressure on the contractile vacuole. Its function appears to be that of a regulating organ, designed to increase the osmotic pressure of the internal medium.

Oct. 10.—The president announced the death of Svante Arrhenius, *correspondant* in the Section of Physics.—Ch. **Fabry**: The calculation of the heat evolved by high frequency currents. A theoretical explanation of some results recently given by M. d'Arsonval.—H. **Douvillé**: The marble of Sarrancolin and the limestones of Haute-Garonne. —L. **Féraud**: The C_{23} correspondences between the surfaces of space in four dimensions.—W. **Goloubeff**: A limited automorph function.—**Grialou**: Plane rotational movement of liquid possessing viscosity, the regime being permanent and the trajectories vertical.—Th. **De Donder**: The fundamental equation of quantic chemistry.—G. P. **Arcay** and P. **Etienne**: The rigidity of liquids.—F. **Croze** and C. **Mihul**: Abnormal doublets and intercombinations in the spectrum of O II.—E. **Darmois** and R. **Descamps**: The natural rotatory dispersion of the molybdo-malic complexes. An extension of earlier measurements into the ultra-violet. The dispersion found was much higher than that given by the inverse square law.—Pierre **Bricout**: The quantitative study of the luminescence of mercury vapour excited by electronic shock.—R. **de Mallemann**: The electrical double refraction of benzil.—Josef **Hrdlička**: The action of potassium permanganate on the photographic plate and infringements of the law of reciprocity.—A. **Andant**: The application of fluorescence spectroscopy to the examination of powdered alkaloids. A detailed account of the technique of the method is given; extremely small quantities of alkaloids can be examined by this method, which promises to be useful as a means of analysis.—Ed. **Chauvenet** and E. **Duchemin**: The purification of beryllia. Starting with commercial beryllia containing 1·5 per cent. of impurities (mainly iron, aluminium, and calcium), heating in a current of phosgene at 450° C. removes the iron and aluminium as volatile chlorides. The residue extracted with water leaves pure beryllia.—J. **Bougault**: Benzalphenylethylsuccinic and benzylphenylethylmaleic acids.—Mme. **Ramart-Lucas**: The mechanism of molecular transformations.—F. **Blondel**: The geology and metallogeny of the zinc deposit of Cho Dien (Tonkin).—E. **Bruet**: The nature and the age of the sediment of the plateaux to the north-east of La Ferté-sur-Aube.—Pierre **Lesage**: Curves of growth and heredity of the precocity character in very different latitudes.—P. **Lasareff**: The theory of the stimulation of nerves and muscles by electric currents of high frequency and short duration.—**Lesbouyries** and **Verge**: The filtering forms of Koch's bacillus in canine tuberculosis.—André **Jousset**: Researches on pulmonary anthracosis.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 9, September).—E. S. **Castle**: The interrelation of the eyes of Palæmonetes as concerns retinal pigment migration. Plaster of Paris and lampblack makes a harmless eye covering, and in Palæmonetes with one or both eyes covered, the pigment in the covered organ takes up the position occupied by the pigment of eyes adapted to darkness. Leaving one eye uncovered does not affect pigment movement in the covered eye.—Henry **Federighi**: The blood-vessels of annelids. Annelid blood-vessels generally and vertebrate capillaries are similar both histologically and physiologically. Both consist of an endothelium with a layer of isolated cells. In *Nereis virens*, contraction of contractile vessels is independent of central nervous control and is of two types, (*a*) peristaltic, due to the endothelium; (*b*) local, due to the isolated cells (*Muskelzellen*) and actuated by direct stimulation.—Jan **Schilt**: The effect of a rotation of the galaxy on proper motions in right ascension and declination.—B. **Knaster** and C. **Kuratowski**: Remark on a theorem of R. L. Moore. The theorem refers to indecomposable continua.—Gordon T. **Whyburn**: Concerning the open subsets of a plane continuous curve.—S. **Lefschetz**: On the functional independence of ratios of theta functions. —E. C. **Watson** and J. A. **Van den Akker**: The direction of ejection of X-ray electrons. Magnetic spectra of the electrons ejected by X-rays from exceedingly thin metallic films show that the most probable direction of ejection is a little forward of perpendicular to the direction of the X-ray beam and is the same whatever level in the atom the electron comes from and whether the absorption energy is large or small. It is difficult to explain these results if the electronic orbits are regarded as having physical reality.—William **Duane**: The character of the general, or continuous spectrum radiation. Electrons from a hot wire cathode were shot into a stream of mercury vapour at very low pressure and the radiation produced by impacts of electrons and mercury atoms was observed by an ionisation chamber. The voltage applied to the tube was less than 12,000 volts (the *L*-series of mercury require at least 12,300 volts and any *M*-series radiations were absorbed), so only general radiation was measured. Under these conditions, with many impacts, the electron transfers almost all, if not all, of its kinetic energy to the quantum of radiation produced, which appears to be very nearly mono-

chromatic.—G. H. Dieke and Harold D. Babcock: The structure of the atmospheric absorption bands of oxygen.—Charles E. St. John: Revision of Rowland's preliminary tables of solar spectrum wave-lengths. The starting point of Rowland's system (1893) was the mean wave-length of the D_1 line of sodium as referred to the standard metre by five observers. In 1893, Michelson and Benoit, and in 1907, Benoit, Fabry, and Perot, using a Michelson interferometer, obtained the absolute wave-length of the red cadmium line in terms of the *mètre des achives*, and this was adopted as the primary standard in the international system of wave-lengths. For many years now, measurements have been made at Mount Wilson, one series utilising simultaneous exposures to the centre of the sun and the standard iron arc with the 30 ft. and, later, the 75 ft. spectrograph, and the other interferometer measurements, and the results corrected for the rotation and orbital motion of the earth. The results are to be issued shortly by the Carnegie Institution of Washington as a "Preliminary Table of Solar Spectrum Wave-lengths."—George de Thierry: Application of the law of similitude to hydraulic laboratory research.—A. Keith Brewer: Some factors influencing the ignition of carbon monoxide and oxygen. The ignition point of an explosive mixture of carbon monoxide and oxygen, using a condensed discharge, is, at constant pressure, determined by the energy of the spark, while at different pressures the ignition points are related as the voltage. Water vapour as an impurity lowers the ignition point, the merest trace enabling the reaction to proceed to completion, whereas in the dried mixture there was seldom more than 10 per cent. completion. Other impurities may be (1) inert except that they absorb energy, increasing the ignition potential (nitrogen, carbon dioxide, chloroform, alcohol, etc.), or (2) oxidised in the explosion and thus lower the ignition potential (water, hydrogen, alcohol, carbon disulphide, etc.). The effect of alcohol depends on the amount of oxygen present. It is suggested that the lowering of ignition potential is brought about by the catalytic activity of 'new-born' decomposition products of the impurity.

Official Publications Received.

BRITISH.

County Borough of Halifax. Second Annual Report of the Corporation Museums for the Year 1926-7. Pp. 20+2 plates. (Halifax.)

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1926. (No. 75.) Pp. 91+2 plates. (Marlborough.) To members, 3*s.*; to non-members, 5*s.*

Journal of the Indian Institute of Science. Vol. 10A, Part 3: Influence of the Sulphur Atom on Optical Rotatory Power. By P. P. Shukla. Pp. 33-41. 8 annas. Vol. 10A, Part 4: The Constitution of the Acid formed by the Action of Sulphuric Acid on Camphorquinone. By Madhay Balaji Bhagvat and John Lionel Simonsen. Pp. 43-55. 8 annas. (Bangalore.)

A List of the Serial Publications available for Consultation in the Libraries and Scientific Institutions of the Union of South Africa. Compiled for the Research Grant Board of the Department of Mines and Industries by A. C. G. Lloyd. New and revised edition. Pp. iv+259. (Cape Town.)

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 11, No. 43, September. Pp. xx+vii+31-45+277-362+229-320+xxi-xxx. (Sheffield.) 10*s.* 6*d.*

Colony of the Gambia. The Annual Report of the Department of Agriculture for the Period January 1st, 1926, to March 31st, 1927. Pp. 53. (London: The Crown Agents for the Colonies.) 5*s.*

British Honduras. Annual Report of the Forest Trust for the Year ended 31st March 1927. Pp. 22. (Belize, British Honduras.)

Report of the Council of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, intended to be presented at the Annual Meeting of the Society, 2nd November 1927. Pp. 40. (Newcastle-upon-Tyne.)

Tanganyika Territory. Report of the Department of Agriculture for the Year ending 31st March 1927. Pp. 46. (London: The Crown Agents for the Colonies.) 2*s.* 6*d.*

Wigan and District Mining and Technical College. Report of the Principal on the Work of the Session 1926-27. Pp. 24. (Wigan.)

Battersea Polytechnic, London, S.W.11. Report of the Principal for the Session 1926-27. Pp. 38. Examination Lists, August 1927. Pp. 36. (London.)

Air Ministry. Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March 1927. (M.O. 298.) Pp. 75. (London: H.M. Stationery Office.) 2*s.* net.

University of London: University College. Calendar, Session 1927-1928. Pp. lxx+x+476+lxxi-ccliv+40. (London: Taylor and Francis.)

FOREIGN.

Observatoire de Zi-ka-wei. Annales de l'Observatoire astronomique de Zô-sè (Chine). Tome 16: Coopération de l'Observatoire de Zi-ka-wei à la revision internationale des longitudes. Pp. iv+156+17 planches. (Zi-ka-wei.)

Classified List of Smithsonian Publications available for Distribution, September 15, 1927. Compiled by Helen Munroe. (Publication 2922.) Pp. vi+29. (Washington, D.C.: Government Printing Office.)

Department of the Interior: Bureau of Education. Publications available September 1927. Pp. 25. (Washington, D.C.: Government Printing Office.)

Social Research Department. First Annual Report. Pp. 8. (Peking: The China Foundation for the Promotion of Education and Culture.)

Reale Istituto Lombardo di Scienze e Lettere, Milano. Nel centenario della morte di Alessandro Volta. Discorsi e note del Presidente Berzolari, dei MM. EE. Grassi e Murani, e dei SS. CC. Somigliana e Volta. Pp. 149. (Milano: Ulrico Hoepli.)

Smithsonian Miscellaneous Collections. Vol. 79 (whole Volume): World Weather Records. Collected from Official Sources by Dr. Felix Exner, Dr. G. C. Simpson, Sir Gilbert Walker, H. Helm Clayton, Robert C. Mossman. Assembled and arranged for publication by H. Helm Clayton. Published under Grant from John A. Roebling. (Publication 2913.) Pp. vii+1199. (Washington, D.C.: Smithsonian Institution.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 328: Testing of Measuring Tapes at the Bureau of Standards. Pp. 16. (Washington, D.C.: Government Printing Office.) 10 cents.

Field Museum of Natural History. Report Series, Vol. 7, No. 1: Annual Report of the Director to the Board of Trustees for the Year 1926. (Publication 243.) Pp. 174+20 plates. Botanical Series, Vol. 4, No. 5: i. Various Spermatophytes, by J. Francis MacBride; ii. Mosses of Peru, by R. S. Williams. (Publication 244.) Pp. 99-139+8 plates. (Chicago, Ill.)

Department of the Interior: U.S. Geological Survey. Bulletin 787: Geology and Ore Deposits of the Mogollan Mining District, New Mexico. By Henry G. Ferguson. Pp. vi+100+25 plates. 65 cents. Water-Supply Paper 569: Surface Water Supply of the United States, 1923. Part 9: Colorado River Basin. Pp. v+189. 25 cents. Water-Supply Paper 574: Surface Water Supply of the United States, 1923. Part 12: North Pacific Slope Drainage Basins. C: Lower Columbia River Basin and Pacific Slope Drainage Basins in Oregon. Pp. v+194+li+3 plates. 35 cents. Professional Paper 149: Correlation of Geologic Formations between East-Central Colorado, Central Wyoming and Southern Montana. By Willis T. Lee. Pp. v+80+35 plates. 50 cents. (Washington, D.C.: Government Printing Office.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Circular Bulletin No. 104: Flies commonly found in Dwellings. By Eugenia McDaniel. Pp. 15. (East Lansing, Mich.)

Bulletin of the American Museum of Natural History. Vol. 54, Art. 3: The Reptiles of Hainan. By Karl Patterson Schmidt. Pp. 395-465+plate 27. Vol. 54, Art. 4: Notes on Chinese Reptiles. By Karl Patterson Schmidt. Pp. 467-551+plates 28-30. (New York City.)

Diary of Societies.

SATURDAY, NOVEMBER 12.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District Meeting) (at Town Hall, Chippenham), at 11.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—E. Cammaerts: The Main Features of Modern English Literature (II.).

PHYSIOLOGICAL SOCIETY (at Institute of Physiology, Cardiff University)

MONDAY, NOVEMBER 14.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Col. H. S. L. Winterbotham: The Triangulation of Africa.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Major E. C. Lambkin: Recent Investigations into the Treatment of Gonorrhœa.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Dr. W. S. Inman: Emotional States and their Relation to Eye Symptoms and Diseases.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. Logan: Brass Foundry Practice.

RAILWAY CLUB (25 Tothill Street, S.W.), at 7.30.—H. A. Vallance: London's First Railway—the London and Greenwich.

ROYAL SOCIETY OF ARTS, at 8.—Prof. H. C. H. Carpenter: Alloy Steels, their Manufacture, Properties, and Uses (Cantor Lectures) (I.).

SURVEYORS' INSTITUTION, at 8.—E. S. Cox: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Bristol).—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

MEDICAL SOCIETY OF LONDON.—Clinical Evening.

TUESDAY, NOVEMBER 15.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. P. C. Varrier-Jones: Village Settlements and the Tuberculous (Mitchell Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir John Herbert Parsons: Light and Sight (III.).

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Sir Arthur Keith and Dr. N. A. Dyce Sharp: Exhibition of Gorilla Skulls.—H. Cott: Exhibition of Photographs taken on the Zambezi.—Dr. W. D. Matthew: The Evolution of Mammals in the Eocene.—F. N. Chasen and C. Boden Kloss: *Spolia Mentawiensea*—Mammals.—A. Loveridge: (*a*) Notes on East African Birds (chiefly Nesting-habits and Stomach-contents) collected 1926; (*b*) Notes on some East African Invertebrates collected 1927.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Dr. O. Faber: Plastic Yield, Shrinkage, and other Problems of Concrete and their Effect on Design.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—W. Wilson: Protective Gear.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Meeting) (jointly with North-Western Centre of Institution of Electrical Engineers) (at Milton Hall, Manchester), at 7.—W. McClelland: The Applications of Electricity in Warships.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—T. F. Langlands: Demonstration of the 'Campro' Combined Kinematograph Camera and Projector.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.15.—M. Paul Painlevé: Les Conceptions Modernes de la Matière et de la Science Classique.

WEDNESDAY, NOVEMBER 16.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Irish District Meeting) (at 35 Dawson Street, Dublin), at 3.30.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. S. Williams: The Milk Supply.

MEDICAL SOCIETY OF LONDON, at 5.—Lord Hewart: Criminal Law and Insanity (David Lloyd Roberts Lecture).

ROYAL METEOROLOGICAL SOCIETY, at 5.—Special General Meeting for consideration of Proposed Alteration and Additions to By-laws.—Ordinary Meeting, at 5.15.—Dr. C. E. P. Brooks: The Influence of Forests on Rainfall and Run-off.—C. K. M. Douglas: The Secondary Depression on the Night of Jan. 28-29, 1927.—Dr. E. Kidson: The Circulation of the Atmosphere over Melbourne.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. W. D. Lang, Dr. L. F. Spath, L. R. Cox, and Helen Marguerite Muir-Wood: The Belemnite-Marls of Charmouth: a Series in the Lias of the Dorset Coast.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—J. R. B. Griggs: Address.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 7.—Miss J. Sharp and others: The Care and Maintenance of Electrical Apparatus.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

MERSEYSIDE AQUARIUM SOCIETY (at 1 Falkland Road, Egremont), at 7.30.—J. W. Cutmore: Aquatic Birds (Lecture).

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Dr. J. A. Murray: Methods for the Demonstration of Bacteria in Frozen Sections.—Miss K. F. M. Kirby: Plastid Development in Osmunda Spores.—Dr. R. J. Ludford: Cell Migration in Tissue Cultures and its Relation to the Repair of Injuries to the Epidermis.

ROYAL SOCIETY OF ARTS, at 8.—Prof. Leonard Hill: Overcrowding in Public Conveyances.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8.—Dr. Marie Stopes: Brief Résumé of the Year's Events.—Mrs. Helen Bowes Pease and others: Discussion on A Consideration of the Position of Labour Women and Birth Control.

INSTITUTE OF CHEMISTRY (Annual General Meeting), at 8.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

FOLK-LORE SOCIETY (at University College), at 8.—Prof. R. W. Chambers: The Story of Offa: a Study of the Growth of a Folk-Tale in England.

EUGENICS SOCIETY (at Royal Society), at 8.30.—Dr. F. A. E. Crew: Concerning Natural Immunities and Disease Resistance.

INSTITUTION OF MECHANICAL ENGINEERS (Bristol Meeting).—Sir William Bragg: Application of X-rays to the Study of the Crystalline Structure of Materials (Thomas Hawksley Lecture).

THURSDAY, NOVEMBER 17.

ROYAL SOCIETY, at 4.30.—Prof. T. G. Brown: (*a*) Absence of a Linear Relationship between Graded Simple Reflex Flexions and the Relations thereof evoked by a Constant Extension Producing Stimulus; (*b*) Absence of a Linear Relationship between the Reflex Flexor Shortenings evoked by a Graded Series of Flexion-producing Stimuli and the 'Inhibitory' Lengthenings of a Constant Extension Reflex evoked by the same Stimuli; (*c*) The Relation of the Magnitudes of Remaining Reflex Shortening in Two Antagonistic Muscles during Compound Stimulation.—Sybil Cooper and D. Denny-Brown: Responses to Stimulation of the Motor Area of the Cerebral Cortex.—*To be read in title only*:—Prof. J. Lorrain Smith and T. Rettie: The Distribution of Lymphatics defined by Autolysis of their Contents.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. R. E. M. Wheeler: London before the Norman Conquest (I.).

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

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Capt. B. S. Cohen: Apparatus Standards of Telephonic Transmission, and the Technique of Testing Microphones and Receivers.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, at 6.—S. G. Visker: The Application of High Pressures to the Reciprocating Marine Steam Engine.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—Open Discussion on Annealing.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry) (Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.15.—Prof. R. M. Caven: Chemical Formulæ of Long Ago.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—H. G. Dunn: Motor Omnibus Design.—F. B. Grant: Cellulose Finish for Omnibus Use.

CHEMICAL SOCIETY, at 8.—B. Cavanagh: (*a*) Differential Potentiometric Titration. Part I. Simple Method. (*b*) Part II. Refined Method.—Miss F. M. Hamer: A General Method for the Preparation of Carbocyanine Dyes.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at London School of Hygiene and Tropical Medicine, Endsleigh Gardens), at 8.15.—Demonstrations by Dr. Mary V. F. Beattie, Major H. C. Brown, Dr. P. A. Buxton, Dr. A. Castellani, Capt. W. Dye, Dr. H. M. Hanschell, Col. S. P. James, Col. Clayton Lane, Dr. P. H. Manson-Bahr, Dr. N. A. Dyce Sharp, Drs. J. Gordon Thomson and A. Robertson, Dr. V. B. Wigglesworth, and Dr. C. M. Wenyon.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics, Medicine, Surgery, and Orthopædics Sections), at 8.30.—Dr. A. E. Barclay (Electro-Therapeutics), Dr. E. I. Spriggs (Medicine), Mr. Max Page (Surgery), H. A. T. Fairbank (Orthopædics), Dr. A. F. Hurst and Dr. A. C. Jordan: Special Discussion on Radiological Pitfalls.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-upon-Tyne).

INSTITUTION OF MECHANICAL ENGINEERS (Birmingham Meeting).—E. McKie: Boiler House Economy.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Meeting).—Sir William Bragg: Application of X-rays to the Study of the Crystalline Structure of Materials (Thomas Hawksley Lecture).

FRIDAY, NOVEMBER 18.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science), at 2.30.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. Gutteridge: Modern Portland Cement Plant.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—A. Knapp: The Graphic Representation of a Third Dimension.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 7.30.—Sir Murdoch Macdonald: The Nile and the Use of its Waters (Presidential Inaugural Address).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society), at 8.—A. J. Broughall: Some Modern Methods of Recovery of Lubricating Oils.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics, Medicine, Surgery, and Orthopædics Sections), at 8.30.—Discussion on Radiological Pitfalls.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—L. G. Lawrie: The Microscopic Investigation of Artificial Silk Fibres.

INSTITUTE OF CHEMISTRY (Leeds Area Section) (Annual General Meeting (at Leeds).—H. Salt: The Training of a Leather Chemist.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB.—C. J. Allen: British Railways: their Locomotives and Engineering (Lecture).

SATURDAY, NOVEMBER 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—G. Holst: Samuel Wesley and Robert Pearsall (I.).

BRITISH MYCOLOGICAL SOCIETY (at University College).

PUBLIC LECTURES.

SATURDAY, NOVEMBER 12.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Mrs. R. Aitken: Dances of the Pueblo Indians.

MONDAY, NOVEMBER 14.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.30.—Sir William Hardy: Physics in the Food Industry (Lecture No. 13 of the Institute of Physics).

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Principal D. B. Johnstone-Wallace: Laying down Land to Permanent Pasture and the Use of Seeds Mixtures in Arable Farming.

TUESDAY, NOVEMBER 15.

KING'S COLLEGE, at 5.30.—Miss Hilda D. Oakeley: The Philosophy of Personality. (Succeeding Lectures on Nov. 22, 29, and Dec. 6.)

WEDNESDAY, NOVEMBER 16.

KING'S COLLEGE, at 5.30.—Dr. Dorothy Brock: Secondary Education: The Girls' School.

UNIVERSITY COLLEGE, at 5.30.—P. R. James: The Decoration of Bookbindings.

LONDON SCHOOL OF ECONOMICS, at 6.—J. J. Sarjeant: Office Machinery: Demonstration of the Barlock Typewriter.

FRIDAY, NOVEMBER 18.

KING'S COLLEGE, at 5.30.—Dr. C. Anti: The Italian Excavations in Cyrene.

SATURDAY, NOVEMBER 19.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Common Mistakes about Evolution.

CONGRESSES.

NOVEMBER 14 TO 19.

PUBLIC WORKS, ROADS AND TRANSPORT CONGRESS (at Royal Agricultural Hall).

DECEMBER 15 TO 24.

JOURNÉES MÉDICALES D'EGYPTE (at Cairo).