NATURE

SATURDAY, SEPTEMBER 3, 1932

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The Contribution of Science to the Future

THE return of the British Association to the scene of its first meeting in 1831 cannot but suggest interesting comparisons between the position of science in 1831 and in 1932, and in this connexion it is not inappropriate that an engineer should occupy the presidential chair. A hundred years ago the nation was still in the throes of the industrial revolution and the economic depression which followed the Napoleonic wars. Discoveries and inventions in mechanical science had already found application in industry and were producing revolutionary changes in society. The whole structure of industry was being changed; old industries hitherto carried on in the homes were being swept into the mills and factories and new industries had been created. The railway and steamship age was just opening, and was indeed fostered by some of the researches promoted by the Association. Faraday had already made the fundamental discovery which later bore fruit in the dynamo and all the myriad ramifications of the electrical industries.

Much of the unrest of this period was due, however, to the indifference to the social or human consequences with which mechanical and other scientific discoveries had been applied in industry. At the time when the British Association held its first meeting at York, the human aspects of the industrial revolution were just beginning to receive attention, and the movement which a decade later led to the passing of the Factory Acts was then being initiated by Lord Shaftesbury. There is perhaps nothing upon which scientific workers, whether engineers or not, are entitled to look back with more justifiable pride than the steady rise in the ethical standards of the industrial community wherever science has influenced its activities. In 1831 it is fair to say that little trace could be found of the scientific spirit in industry. The discoveries of science had been applied to industry with as much indifference to science as to humanity. During the following century, however, science brought the spirit of service into competition with the desire for private gain, and the perversion of the gifts of science to the exploitation of those least able to look after themselves became less and less tolerable either to the industrial community or to society as a whole.

In this tendency, the tradition of science that the service of mankind should be given precedence over personal advancement has not been without influence, and in particular, engineers have played an important part in the permeation of industrial activities with the ideal of public service. The conception of the scientific spirit as involving the service of the community can be traced in the constitution of the Institution of Civil Engineers even in 1818, as well as in that of the Federated American Engineering Societies. This change in the ethics of industry has affected even economic theory, which has come to acknowledge that co-operation is a nobler ideal than self-interest ; and indications could easily be multiplied to show that as industry becomes more widely influenced by science the obligation to subordinate self-seeking to the common good becomes more widely acknowledged.

The transformation in the ethics of a large section of industry would alone be sufficient to explain the attention directed at the present time to the social consequences of the new industrial revolution. This new industrial revolution has emerged from that of the early nineteenth century so gradually that it is only in the last few years that its fundamental characteristic has been clearly perceived—the substitution of other powers for human physical effort as the working energy of the world's production. The acute reaction on employment of the immense increase in the productive capacity of mankind made possible by science has at last brought us to see that science has given us to-day a new kind of production. Power production embodies a profound and vital change in the relation of human labour to the processes and products of the world's work. Not merely in industry but also in agriculture and in transport, not merely with regard to manual labour but also in regard to clerical work, those greater resources of power and fuller control over the forces of Nature are enabling man to do more with less effort. The mechanical invasion of mankind is still only in its initial stages. More and more the function of labour becomes that of admitting power to the machine and manipulating power controls. The intelligence and responsibility hitherto known as skill in craftsmanship are either displaced or concentrated in a small central staff of experts.

These two significant facts—that output in production has escaped from the limitations imposed by human physical energy, and that actual production to-day is indeed only a fraction of what it might be, if the existing plant were worked to full capacity—apart altogether from the prospect of further mechanisation in the office as well as in the works, have forced society to consider the economic and social consequences of the new forces placed in the hands of mankind. Scientific workers in particular must face those consequences and be increasingly concerned with the moral and social results of their work. The future of civilisation itself depends less upon the increasing powers which scientific discoveries and their application have placed in the hands of men than upon the way in which these powers are used.

The existence of world-wide unemployment and poverty, the sinister shrinking of international trade, side by side with this greater productive power, more abundant crops, and fuller control over Nature have suggested to many that the old objection of the manual worker to machinery is not without foundation. It is useless for the scientific worker to provide the greater productive powers or even more effective ways of protecting crops unless society has an economic and social organisation which provides the appropriate seeds, fertilisers, tools, etc., and cultivators capable of understanding their use. This presupposes some developed system of industry, transport, distribution, and education, in which the cultivator and the inventor can both be fostered. The immense complexity of modern pure and applied science requires a corresponding complex social organisation.

When, however, we turn from the sphere of production to that of commerce and distribution, we enter a world of crude empiricism, secrecy, and mystification into which scientific method or principles have yet to permeate, and exact knowledge and its free interchange is almost totally absent. Our distributive and economic system remains on the basis of a pre-scientific era, wholly unadjusted to the change, and unable to bear the burdens placed upon it by this problem of new and almost incredible abundance. Adjustment is called for and can only be effective when the spirit and methods of science are freely applied in this sphere also, and it is recognised that the new powers involve the release of the general human life from Nature's old exaction of drudgery for a mere pittance. The release into an enlarged and enriched leisure for all men for general human culture would appear to be the only alternative to chronic unemployment.

It is thus not machinery that is at fault but the abuse of the powers which machinery has given to mankind, through mistakes in the economic and political sphere. The application of scientific methods in the fields of distribution and finance has as yet scarcely been attempted or the problem resolved of how proper control is to be exercised over machinery in the face of vested interests, traditional outlook, organisation, and habits of thought better adapted to village industries than to the far-flung factories and communications of the modern world. Machinery, the product of scientific knowledge, can only be controlled by greater knowledge, more widely understood and thoroughly applied. The mistakes in our economic, financial, and distributive systems can only be corrected by the application in these fields of the same scientific logic and strict submission to fact and impartial deduction which have given us the machines.

The contribution of science to these interwoven problems of leisure and distribution is not limited to the impartial examination of problems of finance and distribution. There are also required those qualities of mind which collectively make up the spirit of science—the readiness to face change or adopt new outlooks, theories, or hypotheses, the habits of accurate observation, collection, and arrangement of all relevant facts, the willingness to experiment, the power to formulate hypotheses and to use and test them as tools, not as creeds. These are qualities and habits which cannot be acquired or practised without sincerity of purpose, honesty of thought, and open-mindedness, and it is these, as well as the imagination which the scientific investigator must also possess, that are needed if we are to solve the problems of leisure and distribution. If it is true, as General Smuts pleads, that we need the cool, serious, gentle spirit of science in human affairs, and that the application of the true scientific spirit would make possible such a reign of justice and fair play on earth as only poets have dreamt of, it is also true that without the quality of imagination there can be no inspiring vision, no rising out of the common ruts of thought, either in science, in art, or in religion. The greatest men of science in every age have been men of vision possessed of imaginative powers which enabled their thoughts to pierce through the clouds of ignorance and uncertainty and discover some clue to the truth upon which their experimental genius and critical judgment could later be brought to bear.

There is much about us to suggest that the inspiration of such examples is one of the most important contributions that science can make to the solution of the common problems of humanity to-day. Not merely the technique of scientific method for ascertaining the relevant and undistorted facts upon which effective action must be based, not merely the spirit of adventure and the willingness to face change and to try new methods, essential as they are in the dynamic order of society which science has created, but also the vision of a new order of society in which man has quietly and confidently evolved the powers demanded of him for planning intelligently and co-operating efficiently on an international scale in the utilisation of the abundant resources of the world. As Prof. L. P. Jacks recently reminded us, " a race which emerged from the ignorance and brutality of barbaric ages is quite capable of emerging from mechanisation and standardisation, and will emerge if brave men stand to it ".

Scientific methods offer us a surer hope of the solution of our modern problems than the financial, economic, or commercial considerations which have so long dictated policy. It would be unwise, however, to assert that science alone would be sufficient. Science can assist in the discovery of the right ways for the use of the new powers with which it has endowed mankind, but the endeavours of science to make the world a better place to live in and to help men to be worthier of the splendid possibilities of life will be largely defeated unless there can be brought to bear the moral power which ensures the rightful use of those new powers. To the scientific mind and energy which patiently and impartially sorts out the facts of life there must be joined a sense of values, a moral purpose, and a vision of order and beauty competent to compel action upon the ascertained facts for the ordered development of mankind.

Overshadowed by the financial and political events of last autumn, the centenary meetings of the British Association did not receive their normal share of public attention, but the wise words of the presidential address may well come to be regarded as prophetic by many by whom at the time they were unheeded: " Among the human values thus created science ranks with art and religion. In its selfless pursuit of truth, in its vision of order and beauty, it partakes of the quality of both. More and more it is beginning to make a profound æsthetic and religious appeal to thinking people. . . . One of the gravest tasks before the human race will be to link up science with ethical values and thus to remove grave dangers affecting our future. . . . Science may be destined to become the most effective drive towards ethical values, and in that way to render its most priceless service." As the spiritual development of mankind comes once more in step with material progress, it will be possible for the combined moral, ethical, and scientific forces to build up a well-balanced civilisation from which disease, poverty, and war have been eliminated and men strive only to excel in the service they render, the contribution they offer to the common weal.

Mathematics and Astronomy of the Ancient Jewish Rabbis

Rabbinical Mathematics and Astronomy. By Dr. W. M. Feldman. Pp. xviii + 232. (London: M. L. Cailingold, 1931.) 10*s*. net.

WESTERN civilisation is largely based upon three influences emanating from Mediterranean shores—Hebrew, Greek, and Roman. While the legacy of Rome and the legacy of Greece have been gaining in appreciation in Western literature and thought, there has been a tendency to belittle the Hebraic influences. Things Jewish are almost always subject to exaggeration. There is a prevalent tendency (practically non-existent, however, in Great Britain) to attribute to Jewry the blame for every evil for which a more convenient scapegoat cannot be found, and this sometimes produces, in return, an exaggerated estimate of Jewish virtue and genius. Much that is written about Jews is either accusation or apology, a fact that has to be borne in mind in connexion with a publication like that which forms the basis of the present notice. Anybody writing about rabbinical science is tempted either to find merit where it does not exist or to overlook it where it does exist.

It is, therefore, all the more remarkable that Dr. Feldman, while being neither a professional rabbinical scholar nor a specialist in the exact sciences, has produced this volume, in which, on the whole, the tendency referred to is held in check. That the author has not been entirely successful in this regard indicates the difficulty of being completely objective. In some places it is also due to the author's limitations, both on the rabbinical and on the mathematical and astronomical sides.

Of what interest can it be to us to know how much mathematics and astronomy the Rabbis of the Talmud possessed? It is surely a fact that rabbinical influence upon the advance of the sciences was practically nil, and that, although the Jews in the Middle Ages were as important as the Arabs in the carrying on of the tradition of learning, especially in mathematics, astronomy, and medicine, nevertheless, this function was not due to talmudical influence, but to the Jewish love for learning from any source and for its own sake.

The answer is that it is of some importance, especially to Jews, but also to non-Jews, to understand clearly what have been the main currents of thought in Jewry during the various periods through which it has passed. The fact that the great Jewish thinkers of two thousand years ago are not known to have discovered any important scientific facts or devised any important scientific theories, and were, indeed, not even fully acquainted with what had been discovered by their Greek contemporaries; that, during the Middle Ages, the Jews shared with the Arabs the task of keeping scientific learning alive and fostering its growth; and that, in modern times, the Jews have occupied a place of ever-growing importance in scientific discovery—represents a significant piece of information that should throw light upon the nature of racial and national reaction to intellectual influences.

Dr. Feldman's book attempts to cater both for the scientific worker who knows nothing about the rabbinical life of the Jews and for the Jew who knows nothing about mathematics and astronomy. Perhaps he would have done better to quote frankly any mathematical and astronomical results needed for his book, without attempting to prove them. He sometimes gets lost in the mathematics, and in at least one place his knowledge of astronomy is faulty, namely, where he tries to explain Kepler's laws — which are, indeed, irrelevant to the main object of the book.

Dr. Feldman has also in several places departed from complete objectivity. He claims that, in rabbinic times, the Jewish calendar involved just such complicated calculations as he himself gives in his book. It is fairly certain that nothing of the kind really happened, and that the Rabbis of two thousand years ago used rule-of-thumb methods and very rough calculations in order to deal with the calendar. The Jewish calendar is, in fact, so rough an approximation that, while it represents a creditable performance for the Rabbis of the fourth century, it cannot, nevertheless, claim to have anything to do with evection and parallax, variation and secular acceleration.

The author has, however, avoided some of the traps into which other writers have fallen. He does not mistranslate a famous talmudical paragraph, in order to prove that the Rabbis of the Talmud believed in the Copernican system of the planets. He does not suggest that Rabbi Joshua in the first century A.D. knew about Halley's comet, although he claims that a periodic comet was known to this Rabbi. On the other hand, he strains the text in some places, especially when he refers to a 'tube' used by Rabbon Gamliel in the first century as being a telescope or an astrolabe. There is little in the talmudical text to indicate the nature of this tube, but there certainly is no reason to suppose any anticipation of Galileo. What little there is in the text suggests a round tube with one end open, the other end being provided with a peephole. Probably the length of the tube, divided by the width of the open end, was used as the ratio of a distant object seen to occupy the diameter of the open end, divided by the size of the object. By using some standard object, like an average-sized palm tree, the tube could be adjusted for some fixed distance.

The general conclusion of the author is to assign some merit to the Rabbis in astronomy, but comparatively little in mathematics, except in so far as they were able to apply elementary mathematical theorems to various practical purposes. In a preface, Prof. R. A. Sampson says of the Jews "of the past ages":

"they are interested in subtleties it is true, especially the subtleties of the Law, but not in those of Mathematics, nor of any natural science in which tradition counts for nothing. The regulation of the traditional Calendar forced upon them certain astronomical calculations which were competently performed, but the treatment, as any mathematician can see, is such as would lead to no advance."

This is probably a fair summing up of the situation, although it must be added that a more intimate study of the vast material available, and not dealt with in the present work, tends to prove that the Rabbis knew more and reasoned more scientifically than appears from Dr. Feldman's book. The book can be recommended to anybody who is interested in the scientific history of a unique people that has passed through unprecedented adventures and evolutions. S. B.

Pests of the Countryside

Beasts and Birds as Farm Pests. By Prof. James Ritchie. Pp. xii + 270. (Edinburgh and London: Oliver and Boyd, 1931.) 12*s.* 6*d.* net.

A THOROUGHLY useful book by an expert naturalist, dealing with mammals and birds as useful or injurious to British agricultural operations, and holding the scales fairly and evenly. Nature, if left alone, strikes a working balance between every animal and its natural enemies, but man's unconscious efforts usually load one scale. The nature of the agriculture is an important matter. Starlings, for example, "do great service in a pastoral country, in a corn-growing land they do great damage". We hate them among our fruit, but it is possible that they, like many other 'pests', are, on a balance, really beneficial on account of the vast numbers of slugs, snails, and insects they consume. Certainly we would suppose that stoats and weasels, so hated by the gamekeeper, by their destruction of rats, mice, and even rabbits, save stored corn and growing crops of many times the value of the occasional poultry that they kill.

The house sparrow is, of course, an unmitigated nuisance, and its annual damage is put at the very low figure of £8,000,000. Still worse are the rats, which, if estimated as equal in numbers to man in Great Britain and each doing damage of a penny a week, present a bill of £10,000,000—an estimate surely many times too small. Further, the author refers to brown rats as carriers of influenza, foot-and-mouth disease, and trichinosis, and the last disease and also dysentery may be carried to man. The black rat with its associated fleas are responsible for the spread of bubonic and pneumonic plagues. This may become a serious matter, for the black rat is a climber which might wander from house to house on our aerial networks, so that the new concrete building that clears our basements of brown rats would be of no avail. At any time this question of rats and mice might well become of great importance to public health, and it behoves us to inquire how far the provisions of the Rats and Mice (Destruction) Act of 1919 have been made effective in Great Britain. Assuredly, rats can only be lessened substantially in numbers by collective action.

Farmers may reduce most pests in their neighbourhood and even secure the desirable balance on their farms. Prof. Ritchie tells them how to combat their enemies—mammals interfering with stock, injurious to crops, wasting woodland, and destructive to stored grain. Birds are even more important and bulk larger in his consideration of the matter, all the evidence being summarised and critically and intelligently examined. This is just what is wanted, and the result is a most valuable work of reference and a guide to the practical man who uses his wits. It may be necessary to thin the stock of any bird in any ecological environment, but it is doubtful whether it would be wise policy to carry this out in any part of England to the extent to which it appears to be done in France.

The author coming from north of the Border, we naturally looked for a full account of that major pest, the American musk-rat, which is already widely distributed over Scotland and England. Here, as in the case of the grey squirrel and the little owl, the introduction was unintentional, and Prof. Ritchie truly states that "the worst pests in any country are, as a rule, creatures which have been introduced, accidentally or deliberately, from other places". The musk-rat was introduced into Central Europe about 1905 and has become a major pest that exercises the government of every country there. Its skins are now exported to North America and are no longer leaders in fashionable furs. Brought to England since the War, we now have scores of centres where the musk-rat breeds. They do not, perhaps, do much direct harm to the farmer's crops, but the prosperity of a large part of our agricultural population depends on the safety of the waterways, the banks of which they riddle with their burrowings. It is folly for the government of any civilised country not to use the knowledge that science has accumulated, and assuredly any body of competent zoologists could have foretold the years of unrelaxed efforts and vast expense to which we are now doomed (see " The Musk Rat Menace ", by Martin A. C. Hinton, *Natural History Magazine*, April 1932, 177-184).

The Destructive Imported Animals Act, 1932, has come too late for the musk-rat, but we may inquire as to the competence of the machinery which it presumably sets up. Animals are so varied that no civil servant can know all, and it might be wise for any Government department concerned with animal importations, for pleasure or profit, to ask advice of the experts in the British Museum and of animal science as represented in the Royal Society. We are sure that neither body would neglect to seek the opinions of the author of the valuable volume now before us.

Quantum Theory.

(1) *The Theory of Groups and Quantum Mechanics.* By Prof. Hermann Weyl. Translated from the second (revised) German edition by Prof. H. P. Robertson. Pp. xxii + 422. (London : Methuen and Co., Ltd., 1931.) 21*s*. net.

(2) *L'Atome de Bohr : la mécanique analytique et les quanta, les spectres de multiplets.* Par Prof. Léon Brillouin. (Recueil des Conférences-Rapports de documentation sur la Physique.) La théorie des quanta. Deuxième édition. Pp. 363. (Paris : Les Presses universitaires de France, 1931.) 100 francs.

(3) *The Physical Significance of the Quantum Theory.* By Prof. F. A. Lindemann. Pp. vii + 148. (Oxford : Clarendon Press ; London : Oxford University Press, 1932.) 7*s*. 6*d*. net.

(1) AN English edition of Prof. H. Weyl's well-known book is very welcome ; the book remains a difficult one to read, but to anyone with an imperfect knowledge of German the task will be considerably lightened by the translation. The translation has been made from the second German edition, which differs from the first in that certain chapters, notably Chap. v., which originally were more condensed and harder to understand than the rest of the book, have been rewritten in a simpler way. Also in the third chapter, in which group theory is first introduced, an example, namely, the Chbsch-Gordan series, is given of a group and of its reduction. Another welcome addition is a discussion of the Heisenberg-Pauli theory of the quantisation of the radiation field, which has appeared since the first edition of Prof. Weyl's book.

It has been rumoured, as Prof. Weyl admits in his introduction, that the ' group pest ' is disappearing from theoretical physics. It is certainly true that, thanks to the work of Slater, Bloch, and others, the chief applications of quantum theory to spectroscopy and chemistry can be understood without mastering the notation of group theory. It is probable that group theory will in the future prove more useful in other fields, as, for example, in the search for a satisfactory synthesis of relativity and quantum mechanics. To anyone hoping to embark on such a task, or wishing to understand the work already done in this field, Prof. Weyl's book does not need recommendation.

(2) To the future student of the history of theoretical physics, Prof. Brillouin's book will be invaluable; for it expounds, with the lucidity and elegance that one expects from a Frenchman, the Bohr-Sommerfeld theory of the quantisation of orbits, as it was in 1924, before its methods finally gave place to those of the new mechanics. Some 140 pages are devoted to relativity, electromagnetism, and general dynamical theory ; the Bohr-Sommerfeld theory occupies the rest of the book.

The book is theoretical, there being no description of experiments. Such matters as Zeeman effect, multiplets, relativity correction, and spinning electron are dealt with. There is a detailed discussion of the theory of penetrating orbits, showing the very rough agreement with experiment that could be obtained with the old theory. Nothing but praise can be given to the way in which the subject matter is presented ; the reviewer would only question whether it was worth while to write such a detailed account of a physical theory which is now largely superseded.

(3) Prof. Lindemann's book is an attempt to show that some results of the wave mechanics, such as the exclusion principle and the quantisation of energy, are consequences of the Heisenberg uncertainty principle and of the resultant failure of the spatio-temporal description of physical phenomena. In the opinion of the reviewer, the attempt is not successful, because, although the author makes

it appear plausible that some kind of quantisation results from the uncertainty principle, he does not attempt to deduce Schrödinger's equation. It is surely of little use to attempt to explain such a phenomenon as quantisation, unless one can shed light on the origins of the equation from which the exact values of the energy levels can be deduced. N. F. M.

Short Reviews

A Handbook of Child Psychology. By John E. Anderson, Charlotte Bühler, Anna Freud, Arnold Gesell, Florence Goodenough, Leta S. Hollingworth, Susan Isaacs, Harold Ellis Jones, Mary Cover Jones, Vernon Jones, C. W. Kimmins, Heinrich Klüver, Kurt Lewin, Helen Marshall, Dorothea McCarthy, Margaret Mead, Joseph Peterson, Jean Piaget, Rudolf Pintner, Lewis M. Terman, Beth L. Wellman, Helen T. Woolley. Edited by Carl Murchison. (The International University Series in Psychology.) Pp. xiii + 711. (Worcester, Mass.: Clark University Press; London: Oxford University Press, 1931.) 22*s.* 6*d.* net.

The subject of child psychology is really a very old one, although the interest displayed in it by so many psychologists, medical men and lay persons, is very largely a post-War phenomenon. Prof. Carl Murchison presents us with an extremely varied and well-balanced selection of papers by authorities on problems of child psychology the world over. In his preface he mentions the omission of a chapter on the delinquent child and calls for discussion. It is admittedly difficult to deal adequately with delinquency in children in a single chapter, but we think that the subject belongs very much more to the realm of psychology than to that of sociology. One has only to read Burt's "Young Delinquent" to realise the wide ramifications of delinquency when regarded as a psychological problem. We would very much welcome two or even three chapters devoted to delinquency in the next edition. The chapter devoted to eating, sleeping, and elimination is well done but seems rather long. The chapters by such authorities as Piaget and Bühler need no recommendation, since they are typical of the high standard one expects.

Mechanical Testing: a Treatise in Two Volumes. By R. G. Batson and J. H. Hyde. (The Directly-Useful Technical Series.) Vol. 1: *Testing of Materials of Construction.* Second and enlarged edition. Pp. xv + 465 + 68 plates. (London: Chapman and Hall, Ltd., 1931.) 21*s.* net.

Since the first issue, just ten years ago, of the admirable treatise by Messrs. Batson and Hyde on the testing of constructional materials, notable developments have taken place, particularly in regard to the standardisation of methods of testing. The British Standards Institution has issued a number of important specifications, and advantage has been taken of the opportunity afforded by a second edition of the book to incorporate in full measure the Institution's requirements. The chapters on fatigue testing, hardness testing, and testing at high temperatures have been enlarged in order to record the rapid progress made in these branches of work. These and other additions and emendations enhance the value of a work which has already gained a well-merited degree of popularity among students and experts alike. B. C.

Co-operation in Danish Agriculture. By Harald Faber. An English adaptation of "Andelsbevœgelsen i Danmark" by H. Hertel. New edition. Pp. xxii + 188. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1931.) 9*s.* net.

It is not surprising that the first edition of Mr. Faber's excellent book is exhausted and that a second edition should be called for. In this he has embodied the results collected by Mr. Hertel and published in 1929, so that he has been able to bring his information up to date; he has also incorporated material from recent official statistical publications in Denmark. The book appears at an opportune moment, when the agricultural policy of Great Britain is being seriously reconsidered, and when the co-operative methods which have done so much for Denmark are being studied with the view of seeing if they would not prove equally helpful here, at any rate with appropriate modifications. Mr. Faber's account is authoritative, lucid, and impartial; the book can be commended to all students of agricultural problems.

Le problème de l'évolution. Par Prof. Maurice Caullery. (Bibliothèque scientifique.) Pp. 448. (Paris: Payot et Cie, 1931.) 40 francs.

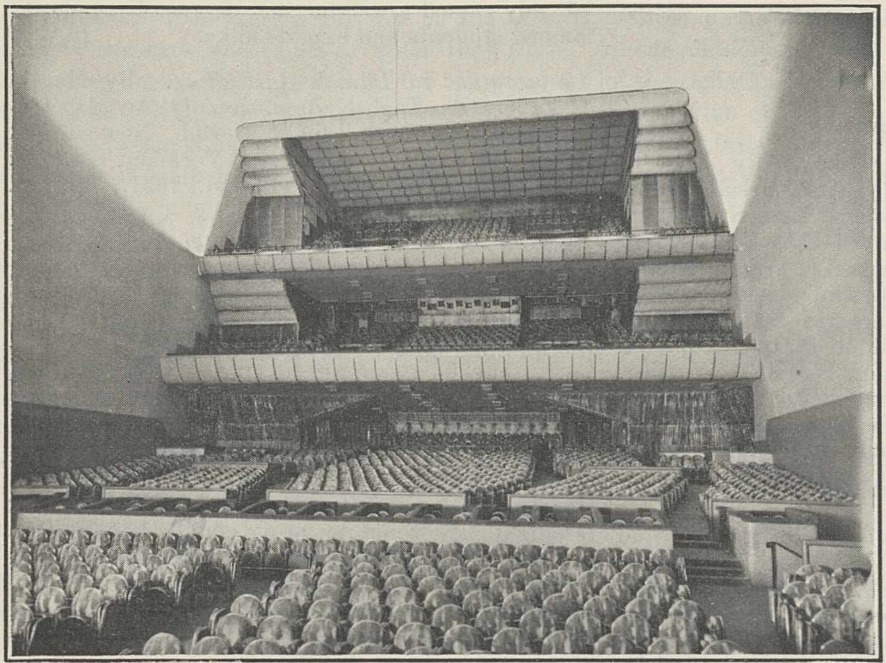
In this excellent work, the author covers, in just over four hundred pages, all the fundamental landmarks and theories of the epic of evolution. The first part of the book is mainly devoted to a discussion of the palæontological discoveries supporting evolution, while the second part explains and criticises the various theories put forward to explain evolution. The author is not entirely satisfied with mechanism, and mentions the doctrine of emergence as offering a suggestive ground for reconciling facts and theories. Yet he does not find it wise, at the present state of our knowledge, to venture into dogmatic assertions about the final value of evolution. T. G.

Conditions and Consequences of Human Variability. By Prof. Raymond Dodge. Published on the Louis Stern Memorial Fund. Pp. xi + 162. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1931.) 11*s.* 6*d.* net.

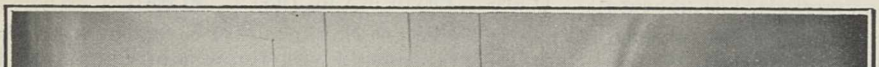
Prof. Dodge has discussed the significance of variability of mental development. The author groups himself amongst the supporters of the *Gestalt* movement: he calls himself a "behaviouristic Gestalt". He is not satisfied with psycho-physical parallelism, and puts forward his hypothesis of apperceptive integration, that is, an integration which would approximately result in consciousness and which takes place in the brain.

The Salle Pleyel, Paris, and Architectural Acoustics

THE meetings of the Second International Congress of Electricity, recently held in Paris, took place in the great building newly constructed by the Pleyel Company in the faubourg Saint Honoré, and there are probably few among those present who were not impressed by the faultless acoustics both of the Great Hall, where the inaugural and other meetings were held, and of the so-called *Salle Chopin*, where the meetings of Section 1, devoted to pure physics, occurred. The Great Hall can accommodate some three thousand auditors, and yet, as the present writer proved, a speaker reading from a paper in the ordinary tone of a lecturer in a small class-room can be heard perfectly in various parts of the hall, including the back of the upper gallery, more than fifty yards away. The principles upon which this hall was designed by M. Gustave Lyon are very simple, but there is no doubt as to their efficacy in this and other examples of his work.



Photo] [Chevojon.
FIG. 1.—Auditorium of the Salle Pleyel, seen from the stage.



Photo] [Chevojon.
FIG. 2.—Stage of the Salle Pleyel, seen from about the middle of the parterre.

The reflections which take place at the walls of a hall are absolutely necessary for good hearing, since without reinforcement of this kind a normal speaking voice is inaudible at a very short distance. A curious experiment was carried out by M. Lyon on this point at Challais-Meudon. Two observers were suspended by cords below small balloons, which could be manœuvred to any desired distance apart, and it was found that, under such conditions, the speaking voice was quite inaudible at a distance of 11 metres. Similar results have been obtained on plains covered with soft new-fallen snow, which is a very bad reflector of sound, while, on the other hand, on perfectly smooth water at night a normal voice can be heard at a distance of more than a mile. Reflections are, then, indispensable.

On the other hand, if the interval between the reception of the direct and of the reflected sound is too large, an unpleasant effect is produced which with increasing interval soon resolves itself into two distinct sounds. Estimates of the maximum permissible interval naturally vary somewhat. According to Ernst Petzold, it should not exceed $\frac{1}{20}$ sec. M. Lyon has carried out extensive experiments with trained musicians as his collaborators, and finds that a slightly longer interval may be

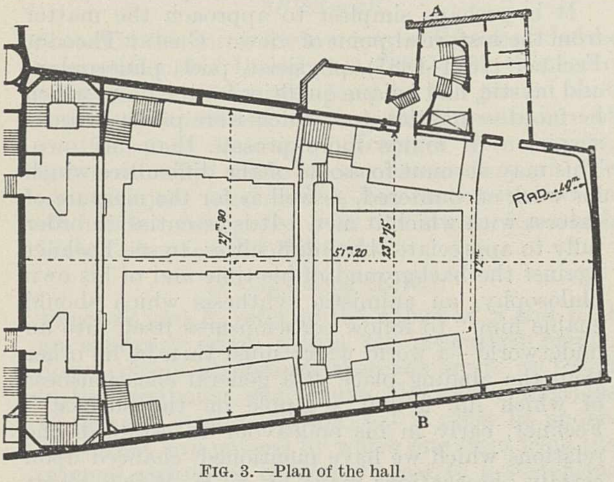


FIG. 3.—Plan of the hall.

allowed in practice. The least permissible interval is greater with such sounds as those of an orchestra than with staccato sounds, such as the noise of castanets or of an actor dying in the prescribed mode, and appears to run up to $\frac{1}{10}$ sec. for the former, but not to exceed $\frac{1}{15}$ sec. for the latter. In any event, $\frac{1}{15}$ sec., or, expressed as sound path, 23 metres, may be taken as a practical limit to which to work. This at once restricts the depth of the stage to 11 metres, if good reflection from the back wall is taking place, and, for the sake of listeners to one side, the breadth to 23 metres, if the whole stage is to be occupied by, for example, an orchestra. The stage in the *Salle Pleyel* is actually about 20 metres wide by 10 metres deep.

A hall is bounded by floor, ceiling, wall at back of stage (which we will call stage wall), side walls, and wall opposite stage (which we will call back wall). Any hall for a large audience will be much more than 11 metres long, which means that any echo from the back will make, for people near the stage, more than the permissible interval with the direct sound. Such echoes should therefore be completely suppressed. In the *Salle Pleyel*, this is effected by treatment with a special sound-absorbing material applied to curved surfaces, the general arrangement of which is clear, without lengthy description, from Fig. 1. The floor, with its padded seats, is a very bad reflector, and in any event waves reflected from it will strike the back wall and be absorbed. The side walls, as can be seen from Fig. 3, are thrown back so as to make an acute angle at the stage end. This allows a larger capacity than if they were parallel, and also ensures, as can be seen, that no reflection from the side walls can, with respect to the direct sound, lead to an interval exceeding the allowable limit. There remain the stage wall and ceiling, which are treated as essential reflectors, in the following manner.

The stage wall, *AB* in Fig. 4, has its vertical profile in the form of a circle, inclined so as to throw the sound over the whole parterre, and is 7 metres high. The distance *SA* is about 10 metres, so that, with this height, the interval between direct and reflected wave does not exceed $\frac{1}{15}$ sec. If *AB* were much higher, this condition would not be satisfied. The horizontal profile is likewise approximately circular, as shown in Fig. 3. The first part of what may be called the ceiling is the reflector *BC*, designed to throw the sound into the first gallery. The vertical distance between *B* and *C* is likewise 7 metres, and the interval condition is satisfied, as it is by the third reflector *CD* which completes the covering of the hall, and throws the sound into the second gallery. The harmonious appearance of the curves is shown by Fig. 2, which is a view of the stage from the middle of the hall, behind the row of boxes. The excellence of the hearing, even from the back of the second gallery, has already been mentioned.

The Pleyel building contains, besides the two smaller halls, of excellent acoustics, many other features of interest to the physicist no less than to the musician. There are a large number of absolutely sound-proof studios, each of which is a room of light construction; the whole weight of this room rests on a layer of sound-proof material, spread on the floor of a slightly larger enclosing room which forms part of the main structure. No conductor of sound, such as a nail or screw, connects the interior room with the framework of the building. The interior room has its own separate windows, opposite those of the main building. Here again the effectiveness of the design is astonishing, the most muscular piano-playing in one studio being completely inaudible in the next.

M. Gustave Lyon's very simple principles have found, perhaps, their most striking exposition in

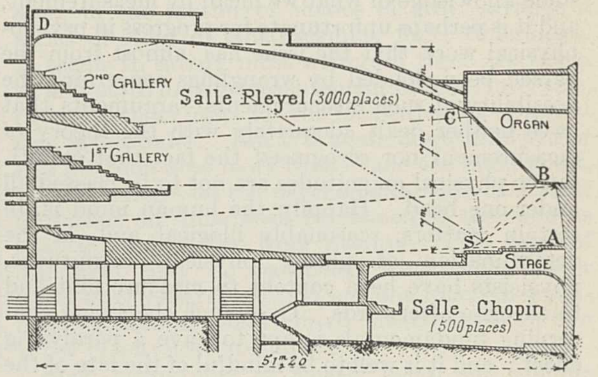


FIG. 4.—Vertical section of the hall.

the Great Hall, but he has behind him a series of remarkable achievements in the way of remedying, at small cost, the bad acoustics of certain halls, of which the best-known example is, perhaps, the hall of the Trocadéro at Paris, once notorious for its execrable sound properties, but now extremely satisfactory. His work is an excellent example of how far a little sound physics can be made to go in the hands of a man of bold originality and energy, who makes experiment and experience his guides.

E. N. DA C. ANDRADE.

Quantitative Estimates of Sensory Events

By Dr. ALLAN FERGUSON

An immense mass of literature has accumulated around the problem which was stated by Fechner more than eighty years ago as that of measuring the increase of a mental intensity in terms of the relative increase of the corresponding physical energy. His problem, in fact, was that of finding a quantitative measure of certain subjective sensations.

Other qualities apart, we can say of two sensation-brightnesses that they are *equal* in magnitude, that one is *greater* than the other, that one is *just perceptibly greater* than the other ; the same may be said of two sensation-loudnesses. It is an unfortunate fact that such terms as loudness or brightness are used indiscriminately, sometimes in reference to the magnitude of the sensation, sometimes in reference to the magnitude of the stimulus which produces that sensation. It is desirable to adopt a uniform practice and, in what follows, these terms will be applied solely to the subjective sensations involved.

It seems, then, that just as in the region of physical stimuli we can use such terms as *greater*, *less*, and *equal*, so in the region of sensory events we can, and do, use the same terminology. Loudness and brightness are magnitudes, in the sense that colour and shape are not magnitudes. Are they quantitative magnitudes ? Can we say by *how much* one loudness, or one brightness, is greater than another ? This is a fundamental problem for psycho-physics, and it is essentially the question which Fechner essayed to answer.

Obviously the answer, logically treated, demands some knowledge of what we mean by measurement, and it is perhaps unfortunate for progress in psycho-physical work that the issue has, almost from the outset, been clouded by wranglings concerning the possibility of such measurements—arguments that have neither dealt adequately with the theory of measurement nor recognised the fact that quantitative physical magnitudes are not to be classed all under one head. Happily, the human mind is, in certain matters, reasonably illogical and, in the determination of purely physical magnitudes, physicists have been content to measure first and to theorise afterwards. Overmuch theorising concerning fundamentals is apt to have a paralysing effect ; and it is well to be mindful of the fate of the centipede, who

"... was happy quite,
Until the frog, for fun,
Asked her which leg went after which,
Which raised her doubts to such pitch,
She lay distracted in a ditch,
Not knowing how to run ".

The psycho-physical measurements with which we are concerned have felt something of this paralysis ; it is therefore a favourable augury for progress when we find Dr. R. A. Houstoun and Dr. L. F. Richardson, from different lines of approach, making quantitative measurements of sensation, without troubling overmuch to discuss their possibility.

It is perhaps simplest to approach the matter from the historical point of view. Gustav Theodor Fechner (1801–1887), physicist, poet, philosopher, and mystic, had unique qualities for the tasks which he faced—qualities, too, which were prone to raise suspicion in minds more prosaic than his own. This may account for some of the difficulties which his work encountered, as well as for the measure of success with which it met. It is essential, in order fully to appreciate those difficulties, to see Fechner against the background of his time and of his own philosophy, an animistic synthesis which should enable him " to follow consciousness itself into an underworld—a world which must then be no other than the abiding place of a general consciousness of which life is but a ripple on the surface ". Fechner, early in his endeavour to establish the relations which we have mentioned, chanced upon certain observations made by E. H. Weber about 1831. Weber had noted that, in a test on weight discrimination carried out according to certain specified rules, a skilled observer who could just discriminate between weights of 29 and 30 drams, could also just discriminate between weights of 29 and 30 ounces. Further, this relative sensitiveness remained the same over a fairly wide range. As it is usually stated, if, when the magnitude of the stimulus (*Reiss*) is R the just perceptible increase is δR, then, over a certain range,

$$\delta R/R = k.$$

The value of k in this particular instance is about 1/30.

With due precautions concerning experimental technique, and correct interpretation of the psychological conditions, the law holds for the sensory qualities associated with such diverse stimuli as sound, light, pressure, and even the stimulus to the sense of smell.

It must not be imagined that the law holds over more than a limited range. It obviously fails at the threshold of sensation and, if $\delta R/R$ be plotted as ordinate against R as abscissa, a curve results which is approximately horizontal over a very limited portion only—and it is to this portion that Weber's law applies.

Whether, however, $\delta R/R$ is constant, or is some complicated function of R, is a matter of little weight for the development of the rest of the argument. Let us, for the moment, confine ourselves to the region within which $\delta R/R$ is approximately constant. It is customary at this stage to point out (and the present writer confesses to what seems to be a lapse) that Weber's law, as thus stated, is quite unexceptionable, inasmuch as it is concerned exclusively with physical stimuli—weights which may be measured in dynes or in grams weight, sound intensities which may be measured in watts per square centimetre, and so on. This is, perhaps, not quite correct, for, after all, δR is the *just perceptible* increase—the increase corresponding to an increase δS in sensation. What we have written as δR should therefore be written as a differential coefficient, and the statement of Weber's law should read

$$\delta R/\delta S = kR.$$

Stated in this form, the law may still be regarded as unexceptionable, though it is conceivable that some purist may criticise this form on the ground that it prejudges matters by assuming the existence of an *element* of sensation. However this may be, the next step, that of an integration of the equation just propounded, has been criticised on all hands. Integrated over the region for which Weber's law is valid, we find

$$S - S_0 = k \log (R/R_0),$$

where S_0 and R_0 refer to the values of S and R at an arbitrary origin within the prescribed region. Some curious algebraical exercises are to be found in the textbooks which give alternative methods of arriving at this relation, but it must be understood that *any* process by which one steps from the original statement of Weber's law to a statement of some functional relation between S and R involves an integration, implied or overt, and consequently involves the assumption that $\Sigma\delta S = S$.

And why not? It would take too long here to discuss in detail the objections advanced, some of them apparently irrelevant, most of them variations on one theme.

Thus, William James remarks that when we consider sensations only, we are "quite unable to read any clear meaning into the notion that they are masses of units combined. To introspection, our feeling of pink is surely not a portion of our feeling of scarlet; nor does the light of an electric arc seem to contain that of a tallow candle in itself. . . . Introspection shows, moreover, that in most sensations a new *kind* of feeling invariably accompanies our judgment of an increased impression; and this is a fact which Fechner's formula disregards." Again, Stumpf says: "An sich ist und bleibt unlängbar, dass eine Empfindung nicht das Mehrfache einer anderen sein oder wenigstens nicht als solches erkannt werden kann. Mussten wir doch sonst die eine von der anderen subtrahiren, und die Rest für sich empfinden können. Jede Empfindung präsentirt sich uns als ein Unteilbares." This oft-quoted criticism has been regarded as final. None the less it possesses an inherent weakness which is best exposed by quoting Lewis Richardson's happily inspired parody—"One mountain cannot be twice as high as another. If it could, we ought to be able to subtract the one from the other and to climb up the remainder by itself. Every mountain presents itself as an indivisible lump."

Despite these criticisms, we do regularly make quantitative laboratory experiments in which, for example, it is found possible to arrange a series of grey shades from very light to very dark in what appear to be equal steps, and it is also an experimental fact that a comparison of these shades by photometric methods shows that their objective luminosities are in a geometrical progression; this, and similar observations, if interpreted in the sense that they justify the Fechner equation

$$S - S_0 = k \log (R/R_0),$$

are apparently in direct contradiction to the criticisms just quoted. How can we escape the dilemma? Historically, the escape was made by introducing the idea of sense intervals, a notion originally due to Delbœuf, and followed out by later writers. The idea is very clearly formulated by Titchener, who remarks, "the physical . . . magnitude is not a single term but rather a distance between terms. . . . We are apt to say, carelessly, that we have measured 'the highest point' of Mt. Vesuvius, when we have in reality measured, in terms of our arbitrary unit, the distance between its lowest and highest points. It is not the point that is the magnitude but it is the distance between points. So with sensations; we are apt to think of a brightness, or of a tone of given intensity, as a sensation magnitude, as itself measurable. Now the stimulus is measurable; we can measure, in terms of some unit, the amplitude of vibration of the ether or air waves. . . . But the sensation, the brightness or the tone, is just a single point upon the sense scale—no more measurable in itself than the 'highest point' on Mt. Vesuvius. The only thing that we can measure is the distance between two sensations or sense points."

This brings us to another criticism—that whenever we measure an ordinary physical quantity, we express it in terms of a unit of the same kind, of which it is a multiple or sub-multiple. Where is the unit of subjective brightness or loudness, ask the critics? Well, we can arrange a series of steps of just noticeable differences, or we can, as we have seen, in the matter of shades of grey, arrange a series of steps of equal-seeming finite differences. It seems to satisfy most writers if these are taken as unit steps for the measurement of sense intervals, rather than as units for the measurement of sensation magnitudes. But it is again doubtful whether this attitude does more than evade the main point.

Most writers on the psychological side base their criticisms on some such fundamental assertion as that quoted earlier from Stumpf. This type of argument may be paralleled from many other parts of the literature. It has one inherent weakness—it does not discriminate clearly between two types of physical magnitude.

Such magnitudes as length, mass, and volume may be very readily conceived as being built up of units spatially juxtaposed in such a way that a unit length plus a unit length gives a length of two units, and so forth. But there are other physical magnitudes of which this is certainly not true, and yet on which quantitative measurements are regularly made. What, for example, is the result of adding, in the sense just used, a density of one to a density of one? Or a unit temperature to a unit temperature?

There is a host of such quantities—magnitudes such as surface tension, viscosity, density, diffusion coefficient, and the like, which are not fundamental magnitudes of the type previously discussed, but may none the less be measured quantitatively. Whether the magnitudes concerned are fundamental or not, a mass, a temperature (not a hotness), a viscosity, even though they may be conceived artificially as built up by the multiplication of a certain unit quantity, do surely present themselves to introspection with the same singularity as does, say, a sensation-brightness.

Moreover (we are now in the region of physical stimuli), even though a physical magnitude X may present itself to introspection as a whole, if we find that X varies with temperature in such a way that $dX/d\theta = f(\theta)$, we have no hesitation in integrating to obtain a functional relation between X and θ, and are led thereby into no contradictions. So, while fully recognising that in one instance we are making deductions from introspection concerning a physical magnitude, and in the other instance from our judgment concerning a subjective sensation, we do not find ourselves led into any morass of contradiction if we regard a just noticeable difference or an equal-appearing interval as a unit of sensation, and artificially regard any sensation magnitude as so many times greater than that unit.

This is, apparently, what Dr. Houstoun does—and in doing so ingeniously avoids difficulties arising from departures from Weber's Law—when he plots $R \div (\delta R/\delta S)$ as ordinate against ($\log R$) as abscissa. Since $d(\log R)$ is equal to $\delta R/R$, it follows that the area included between two ordinates separated by the small interval $d(\log R)$, the x-axis, and the element of the curve is equal to δS. Consequently, if $\Sigma\delta S = S$, the magnitude of the sensation corresponding to any stimulus R, is given by the area underneath the curve up to the ordinate at the point considered. This expresses an important advance. Incidentally, Dr. Houstoun finds that the curve obtained is very closely a Gaussian probability curve.

Other minor criticisms may be briefly noted. It has been remarked that the quantity $S - S_0$ does not represent a difference between two experiences, but an experience of difference. " The expression $S - S_0$ represents a single state of consciousness, the experience of a difference. It admits neither of dissection nor of mathematical treatment." Such a statement is merely dogmatic. Again, criticism of the choice of a just noticeable difference as a unit is contained in the remark that Fechner " regarded a sensation as the sum of a number of just appreciable unit increments of sensation. . . . He maintained that the change of sensation, obtained by adding one ounce to a weight of twenty-nine ounces was absolutely the same as that obtained by adding one dram to a weight of twenty-nine drams. *Of course, were this so, an ounce and a dram should produce an equal sensation.*" The italics are the present writer's. Comment is surely unnecessary.

Dr. L. F. Richardson has approached the matter from a different viewpoint. He endeavours to measure a sensation S " by directly estimating the *ratio* of unequal intervals both much larger than the least perceptible ". Thus he has, from 316 observers, obtained estimates of the redness of certain pinks, these estimates being made by putting points on a line divided into 100 equal parts, white being zero, and red 100. The inquiry has been elaborated by mixing on a colour-wheel white and red in different proportions and estimating in the same way the redness of the resulting colour. If X is the position of the mark on the red scale and the angular amount of red (measured as a percentage of 360°) is θ, R. S. Maxwell finds that the results of 35 observers may be represented by $(\theta - 156)(X + 56) = -8736$.

One word concerning the *decibel*. This may, or may not, be used to define a unit of sensation-loudness. The physical measure of the intensity of a musical note of a given pitch rises, apparently, at a much more rapid rate than does the judgment of its sensation-loudness. If we measure physical intensities in, say, micro-watts per square centimetre, we obtain a series of numbers 1, 10, 100, 1000 . . . ., or 10^0, 10^1, 10^2, 10^3 . . . . As a matter of mere convenience it may be advisable to represent these intensities by the series 0, 1, 2, 3 . . . ., and we thus obtain a logarithmic scale of intensities of which the unit has been called the *bel*. One-tenth of this unit is the decibel, and it does happen that this unit corresponds fairly closely to the just noticeable difference of sensation-loudness between two notes of the same pitch at moderate intensities. But primarily the decibel represents a unit of intensity on a logarithmic scale, and need have no more to do with sensation measurements than has a scale of cents in the realm of music.

It is evident that, despite the amount of adverse criticism that has been brought to bear on Fechner's interpretation of Weber's Law, the matter is by no means closed, and that even the long-standing evasion of the difficulties in terms of sensation-intervals may stand in need of revision. The joint discussion between Sections A and J at the York meeting of the British Association should do much to clear up the major points at issue.

Obituary

Mr. H. G. Watkins

THE tragic death on Aug. 20 of Henry George Watkins at the age of twenty-five years has removed the most promising and, indeed, the most prominent figure amongst British arctic explorers, a figure as yet too recent to be familiar to those outside a small circle.

The stages of Watkins' rapid advance to the forefront are simply told. At the age of nineteen, while still an undergraduate at Trinity College, Cambridge, he led a summer expedition to Edge Island in the Spitsbergen group. At the age of twenty he spent an arduous year in Labrador with one companion, J. M. Scott, the full story of which has not yet been written. At the age of twenty-three he led the British Arctic Air-Route Expedition of 1930–31 in Greenland, a venture which is destined to be an important milestone along the road of polar history.

The full significance of the Greenland expedition has probably not yet penetrated the mind of the public, which was intrigued by and slightly critical of the dramatic events which surrounded the relief of Courtauld after his five months' sojourn alone on the ice cap. The narrative, now in the hands of a publisher, will correct some of the misapprehensions and will prove to the readers that here was a new type of expedition, following no former pattern: for Watkins ventured greatly without the lead of tradition; indeed, he constantly questioned the value of traditional methods and devised new and original ones of his own.

Led by Watkins, this group of young and inexperienced men set to work to disprove the wise saws of tradition, to dare great things and to carry them through. In a matter of weeks they were doing what was said to be safe only after years of experience—to drive dog-sledges, to hunt in the Eskimo method, to learn the kayak, to cross the ice-capped continent, to 'live on the land'.

In a crowded year those fourteen men accomplished enough journeys, by air, by sledge, by kayak and motor boat, to be a credit to half a dozen expeditions. A splendid set of men, it is true, but they will all admit that their results were due to the qualities of their leader and to the utter confidence they had in him. Of some of them the world will hear in due course, for they have been trained by the amazing young man whose loss we now deplore.

Of slight build, though strong and supple, somewhat shy and diffident in conversation, there was little in Watkins' appearance to mark him for what he was. Indeed, to the casual glance, his well-groomed figure, his neatly parted hair, his charming but hesitant manner, were signs merely of a pleasant young man who would always follow the precept of others and live quietly but efficiently in some ordinary walk of life. A conversation with him began to awaken doubts as to his being merely that. The alert poise of his head, the quick seizure of essentials, the calm statements of daring plans, all betokened a man of ideas and with the will to carry them out.

Even so, it was not until one saw Watkins in action that one realised his full qualities. It matters not what the action might be, wrestling with a friend, scaling a mountain-side, or, better still, as can be seen in the film of his expedition, 'rolling' a kayak. At one moment he is at ease, smiling and joking, like any other debonair young man; at the next he is tense and alert, head thrust forward, jaws set, and eyes shining with an expression almost grim, balancing his craft for a moment. He flings himself backwards and there is a flurry of paddle and arms, a swirl and a splash, and there he is again, relaxed and at ease, with a shy smile as though he were rather ashamed of his relapse into intense activity.

There must be added to this picture a shy dignity and a charm of manner, a modesty and a thoughtfulness which won all hearts. That is why Dr. H. R. Mill, in his appreciation in the *Times*, used the apt phrase, "so dear a scientific adventurer as 'Gino' Watkins"; that is why his companions would do anything for their leader, and why the news from Greenland has come as the shock of a bullet to his friends.

F. D.

News and Views

Function of the British Association

In suggesting as one reason for the continued success of the British Association the opportunity it affords, in an age of specialisation, for laymen to have intelligent contact with the seekings and findings of the scientific mind and for science to expound its own broad outlook, Sir Alfred Ewing, whose presidential address is printed in our Supplement this week, is on firm ground. The passing of the arrogance characteristic of an earlier age, the widespread belief that there are in science no longer any rigorous laws but only laws of probability, have made for a spirit which strengthens the sense of brotherhood between the scientific expert and the average man, who in his own way is also commonly a seeker after truth. The disappearance of dogma alone should assist the formation of an alliance which is overdue if we are to carry over into human affairs the methods of science and apply the dispassionate temper of science to the solution of our social, economic, and international difficulties.

Progress in Engineering Science

After an engineer's review of the rapid progress in the study of the atom during the last few decades, including the discoveries of the neutron and the splitting of the lithium atom described this year, Sir Alfred Ewing referred to the important contribution of the Association to the advancement of engineering science. Early reports submitted to the Association demonstrated the conspicuous lack of science on the part of early British engineers, and the meagre contributions being made by them to the progress of hydraulics in contrast with the contributions of Italy, France, and Germany. The claim that the British Association by its reports and investigations, its discussions and committees, such as those leading to the establishment of the National Physical Laboratory and international standards for electrical units, has provided an invaluable scientific leaven, few would care to dispute. In his own recollections Sir Alfred Ewing covers the passing of many of the former fairy tales of science into the tissue of everyday life, and in the transition British engineering science has made as important scientific as practical contributions.

The Future of Science

A conspicuous feature in any such review is bound to be the realisation of the accelerated pace at which development proceeds once the science has advanced well beyond its nursing stage. The pace of these developments is disturbing only because man is ethically unprepared for the bounty which engineering science has brought him. The world has been made practically instant in its interchange of thought, and international co-operation and brotherhood has become much more than a dream, were man fit for the tremendous moral responsibility which the new gifts and potentialities of life entail. Due to the slow evolution of morals, he has, however, not yet learnt to command himself, to relinquish old habits of thought, sovereignty, independence, which are inconsistent with the command of Nature now put into his hands. If the future is uncertain, at least those whose labours have brought such riches to man may be concerned but not despondent. They cannot but believe with Sir Alfred Ewing that the creative ingenuity which has brought these gifts will yet stir man to achieve in the future the better distribution of leisure and labour and the fruits of labour, which are essential to the continued enjoyment of his new powers. So we find the engineer man of science of the present century voicing the ideals of the great biologist of two or three decades ago.

John Locke, 1632–1704

THE tercentenary of the birth of John Locke occurred on Aug. 29 last, and to mark the event Messrs. J. and E. Bumpas, Ltd., have brought together at the Old Court House, Oxford Street, London, W.1, a well displayed and comprehensive series of engravings, manuscripts, and printed books, including the first edition of Locke's celebrated "Essay on the Human Understanding", as well as letters from Boyle, Newton, Sloane, and other men of his period. The collections are mostly in the ownership of the Earl of Lovelace, having happily suffered no disturbance or vicissitudes since their original assignment within the family. Various special loans that have been received greatly enhance the personal, artistic, and literary interest of the series. Thus, the impressive three-quarters length portrait of Locke, from Christ Church, Oxford, is there, whilst recently Lord Lee of Fareham has sent in an early plaster statuette of Locke, by an Italian hand. A letter from Locke, as a schoolboy, to his father, tells of seeing a "company of Quakers" in Westminster Hall, on business bent, whose leader's hat was "shook off"—recalling that Charles II. removed his own hat in the presence of Penn, explaining that it was the custom at Whitehall for only one person at a time to remain covered.

JOHN LOCKE was proposed for the fellowship of the Royal Society, by Sir Paul Neile, on Nov. 19, 1668, and at a meeting in the following week he was elected and signed the charter book. In that year, too, the illustrious Marcello Malpighi was elected. On St. Andrew's Day, Nov. 30, 1672, Locke was chosen a member of council, and Pepys and Evelyn were brought in at the same time. Earlier in the year, at an ordinary meeting held at Arundel House, Hooke had mentioned his interest in Otto von Guericke's experiments. There was one which he thought deserved to be tried before the Society, namely, that of a sulphur ball, when revolved and rubbed, having a considerable attractive power, and representing the properties of the earth. Mr. Locke, so we learn, intimated that himself had made some experiments with such a ball, and promised that he would bring it to the Society at the next meeting. At that meeting, however (Hooke being present), when he was called upon, Locke excused himself; he had forgotten it, and promised it for the next. Thereafter nothing happened, and, as a matter of fact, Locke's interests in the philosopher's doings were eclipsed by other pregnant interests. He seems, though, to have maintained constant intercourse with Boyle, who signs as "Yr. very affectionate friend", saying he looks up to Locke as a virtuoso.

Report on the Post Office

THE Report of the Committee appointed "to inquire and report as to whether any changes in the constitution, status or system of organisation of the Post Office would be in the public interest" has now been published (Cmd. 4149. London: H.M. Stationery Office, 9*d*. net). The Committee, which consisted of Lord Bridgeman (chairman), Lord Plender, and Sir John Cadman, is of opinion that the total transference of all Post Office communication services to a public utility company or statutory corporation is impracticable, and is neither necessary nor desirable. The Committee considers that the main modification in the status of the Post Office which is required is in respect of its relationship to the Exchequer, and it is recommended that the contribution of the Post Office to the Exchequer should be fixed, for the next three years, at £11,500,000 plus 50 per cent of any cash surpluses in excess of that figure, the residue to be available for the improvement and development of Post Office facilities and services.

As regards organisation, the Committee recommends that the control of Post Office business should be effected through the medium of a functional board presided over by the Postmaster-General. In addition to the Assistant Postmaster-General, the board would comprise four or five members of the Post Office staff, such functions as general operating and supply, engineering and research, finance, and personnel being represented upon the board. A senior permanent member of the board would act as vice-chairman and would be styled 'Director-General', with the duty of ensuring that board decisions were made effective and that continuity and unity of policy were maintained. A decentralisation of administration is recommended under regional directors who would exercise jurisdiction over all the services. Stress is laid on the necessity for fluidity of interchange of staff between headquarters and the provinces. The Committee believes that under these proposals the engineer will be able to play a larger and more effective part in the determination and execution of policy, and it is considered that there should be no bar to a technical officer holding an administrative post, provided he has shown himself to possess administrative ability. Contact with the public will be secured by means of an Advisory Council acting in a consultative capacity, and it will be consulted by the Postmaster-General on questions of general policy. The Report is obviously a document of first importance, and we hope to discuss the Committee's recommendations in due course.

Progress and the Scientific Worker

WITH the great changes inherent in modern civilisation, a new outlook has become essential. Science, the handmaiden of progress, cannot be divorced from industry, administration, social problems, etc.; and with this point of view in mind, the new series of *Progress*, which is being published as *Progress and the Scientific Worker*, aims at giving voice to the new citizenship. Necessarily, therefore, within its covers will be found the joint expressions of the scientific and humanistic outlook. This is made possible since it is the official journal of the Association of Scientific Workers and the British Institute of Social Service. *Progress*, the first bi-monthly number of which is for July-August 1932, has made a splendid beginning. Sir John Russell contributes an informative article on "The Coming Generation". He gives an interesting résumé of recent advances in the agricultural sciences. For example, in the harvesting of an acre of wheat, hand work of olden days involved 32 man hours, the early machine 19 man hours, and the modern machine 4 man hours. But the reduction of these man hours by mechanisation has its drawbacks. On one farm in Norfolk, for example, until recently, 40 men were employed, and now, since its 'mechanisation', only 4 are employed. One of the greatest problems of to-day, which will inevitably be handed on to the coming generation, is the employment of such displaced men.

CLOSELY allied to the problems discussed in this article is the paradox of plenty, which is the subject of an article by Mr. Percy Alden. There is a surplus throughout the world of wheat, cotton, tea, coffee, rubber, oil, and tin. Poverty-stricken countries are no doubt desirous of buying, but the purchasing power is absent. Now, there are, according to Mr. Alden, two essentials to recovery from this world-wide depression: international agreement over debts, reparations, and armaments, and an attempt to settle the currency question which is crippling industry in many countries. The inevitable connexion of industrial development with creative science forms the basis of Sir Richard Gregory's suggestive and illuminating article entitled "Science and the Nation". Sir Richard gives many convincing examples of the 'triple alliance' of creative science, purposeful invention, and skilled labour, and the resulting conditions, which have proved of national and international importance. "Science not only creates new means of existence and new sources of employment by the discovery of new principles and substances, but also places extended use of power at the disposal of every one. . . . Modern technical achievement and scientific thought foreshadow a new economic structure for society in which they should be used to exercise decisive influence upon the major politics of the State as well as upon their administration." Through such activities unbounded possibilities are presented to the new generation, including the problem of the displaced manpower discussed by Sir John Russell. Besides other articles of general interest, the new journal contains scientific, social, industrial, and educational news, reviews, and notes. The price is 6*d*. per copy, and the annual subscription 5*s*.

Mohenjo-daro Dating

A FURTHER stage towards precision in the dating of the prehistoric civilisation of the Indus valley is marked by Mr. Ernest Mackay's letter to the *Times* of Aug. 27. Mr. Mackay records the discovery at Mohenjo-daro of a fragment of a steatite vase which bears exactly the same intricate and very unusual pattern as a double vase of the second period of Susa. It was found at a depth of 28 ft. below datum, very little above water-level in the soil when the river is at its lowest. The inference that it was an import from Elam is borne out by the material of the fragment, a greenish-grey steatite identical with that of the Susa II. double vase. A conservative estimate for the dating of Susa II. would place the Mohenjo-daro find at about 2800 B.C. On the other hand, Mr. Mackay points out that the seal, of undoubted Indian workmanship, found by Dr. H. Frankfort at Tell Asmar, is inscribed with animals which occur commonly on seals and sealings at Mohenjo-daro (although as yet only two cylinder seals have been found) and can be contemporaneous only with the upper levels of that site, occurring at some three to seven feet below datum. This, on the basis of Dr. Frankfort's dating of the Tell Asmar seal, would give a dating of 2500 B.C. for the upper levels at Mohenjo-daro—a reduction on the previous provisional dating. It would thus appear that between the lower levels, 28 ft. below datum, and the upper levels, contemporary with the period of the Tell Asmar find, some three hundred years elapse—a conclusion to which Mr. Mackay states that he already inclined on other grounds.

Protection of Antiquities in France

A QUESTION of much interest to archæologists in general, though naturally of more immediate moment to French archæologists, is raised by Dr. R. Vaufrey in the current issue of *L'Anthropologie* (t. 42, Nos. 3-4), in describing certain steps which have been taken by the Prehistoric Section of the Commission des Monuments historiques for the more efficient administration of the law relating to the protection of prehistoric antiquities. It would appear that French archæologists are feeling some alarm lest they should be on the eve of a condition of affairs prophesied by M. Marcellin Boule more than forty years ago, when he foresaw that, unless effective measures were taken, France's priceless store of prehistoric antiquities in the Dordogne would be exhausted. In the opinion of prominent French archæologists, that time is indeed close at hand. Every effort is to be made to avert it. Present financial conditions preclude anything in the nature of the creation of a department for the purpose, but steps are being taken to secure a stricter enforcement of the existing law. The Prehistoric Section of the Commission, which is the body responsible, wishes to place no check on scientific excavation, whether by organisations or individuals properly accredited ; but it aims at the ' amateur ' who seeks to exploit a site for his personal and pecuniary gain. In this praiseworthy object, French archæologists will have the moral support of their colleagues, whatever their nationality, and also in what is clearly their secondary object, namely, to secure the control of the finds—thus averting such a catastrophe as occurred when the skeletal remains found in the caves of Le Moustier and Combe Capelle were lost to France.

Restoration of Roman Bridge, Littleborough, Lancs

Advantage has been taken of the unemployment problem at Littleborough, Lancs, to invite the co-operation of voluntary workers among the unemployed on the ' dole ' in the repair of the Roman road over Blackstone Edge. A part of the work contemplated has now been completed by the repair of the Roman bridge at the junction of Black Castle Clough and Rag Sapling Clough, which carries the road over Black Castle Clough. Some time ago, Mr. J. H. Price of Rochdale directed the attention of the Rochdale Literary and Scientific Society, and through it, of the Society for the Protection of Ancient Monuments, to the fact that the bridge was in danger of being swept away. Mr. Price's examination of the bridge had revealed the fact, which had been completely forgotten in the course of time, that originally it consisted of two culverts, one of which had collapsed and had become completely overgrown with grass. The original length of 25 ft. had thereby been reduced to 12 ft. This culvert has now been restored and the bridge repaired, under Mr. Price's supervision, with the assistance of local firms who volunteered transport, material, etc. The work was carried out with the approval of H.M. Office of Works. Both Roman road and bridge are scheduled as ancient monuments. It is hoped to carry out repairs on part of the road in due course by the same method.

Salamanders and the Pollution of Drinking Water

A curious and unsuspected source of pollution of drinking-water has just been discovered in Cattaraugus County in western New York State (William G. Hassler in *Natural History*, New York, May-June, 1932, p. 303). Certain spring supplies of water continued to give unsatisfactory laboratory tests even after drastic steps had been taken to protect the springs from outside pollution. Further examination revealed that salamanders, large newt-like amphibians, belonging to four different species, occasionally occurred in the springs, and though a first examination showed that only a small percentage contained the colon bacillus, the investigation was continued. Nearly two hundred purple salamanders (*Gyrinophilus porphyriticus*) were marked with identification discs, and subsequent collecting proved that sometimes individuals wandered as much as sixty-five feet from the stream, apparently in search of food. One was observed eating fly larvæ which were living on mammalian refuse, and this settled the question of how colon bacilli entered the food canals of the salamanders. A second surprise was sprung upon the investigators when they studied more closely the numbers of salamanders in the springs themselves. Purple salamanders were not thought to be particularly common, but repeated nightly visits resulted in a catch of 144 in one spring, which contained about fifty more uncaught. Yet there were occasions when not one of these salamanders could be found, although all the catch was marked and returned to its spring. Laboratory experiments gave some idea of the extent to which contamination might take place. Over a period of 122 days, one salamander excreted a sufficient number of colon bacilli to contaminate 237 gallons of water heavily enough to be considered dangerous on every test. It is believed that the creatures act as reservoirs or incubators, and once infected with colon bacilli, continue to excrete them so long as there is food in the stomach or intestines to supply nourishment to the bacteria.

Fishing with Captive Sucking Fish

More than four centuries ago, Columbus observed the strange custom of catching fish and turtles by means of captive sucking fish in the " Jardinellas de la Reina ". The general impression has been that these islands were near Haiti and Jamaica, but C. Ralph de Sola points out that a more likely place is the archipelago in the Bight of Manzanillo on the south coast of Cuba (*Copeia*, p. 45, 1932). If this be so, Gudger is wrong in concluding that the original site of the discovery of Columbus " no longer witnesses the exploits of the fisherman fish ", for the Siboneyes of southern Cuba, a people of Carib extraction, still practice remora-fishing to a considerable extent. De Sola describes a fishing trip from Matanzas, Cuba. To the under-planks of the boat two sucking-fishes were firmly attached by their discs, and when a turtle was sighted basking on the surface, the fishes were detached and cast as far as possible towards the turtle. The sucking-fishes were themselves held captive by a long thin rope of *majuga* bark, attached in front of the tail, and so soon as they had fixed upon their quarry, the lines were drawn in and the captured hawk's-bill turtle taken aboard. Throughout the proceedings the lines had to be kept taut, and the author states that owing to the arrangement of the lamellæ of the sucker, it is impossible for the remora to relax its hold when tension is placed on its horizontal axis. It is curious that so peculiar a mode of fishing should be found in many distant parts of the world, but Gudger's records from various localities in Africa, Asia, Australia, South America, and the West Indies show that it is almost cosmopolitan in tropical seas.

Eradication of Slugsand Snails

In a communication to Nature on the eradication of slugs, which was the subject of a note in these columns on July 16 (p. 90), Mr. Walker Van Riper, 771 South High Street, Denver, Colorado, contributes another method of control based on his own experience. A generous distribution of a solution of ammonium sulphide (1 part in 30 parts of water) killed nearly all the slugs present in his garden in a single

(*Continued on p.* 361.)

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An Engineer's Outlook

By Sir ALFRED EWING, K.C.B., F.R.S., President of the British Association

PRESIDENTIAL ADDRESS DELIVERED AT YORK ON AUG. 31, 1932

AGAIN, for the fifth time, the British Association meets in York, a city of proved hospitality and the stage of great events. York is a monument of history ; its very stones are eloquent of the past. Not the least of the episodes it has witnessed was the birth of this Association. We hold York in filial honour and affection. We are nomads who have strayed to the ends of the earth : we have been as far-flung as the British flag. We have enjoyed the welcome of many strange hearths. But here there is nothing unfamiliar. We take delight in coming home to a birthplace of happy memory and in recalling hopes which the past hundred years have generously fulfilled.

Last year the infant of 1831 celebrated its centenary in the vigour of manhood, with a plenitude of pomp and circumstance which demanded no less ample a setting than the metropolis of the Empire. For president we had a man of world-wide fame, who fittingly embodied the imperial aspect that is part of the glory of the British Association. We had long known General Smuts as soldier and statesman : to some it may have come as a surprise when they found him also a philosopher, a student of ideas no less than a maker of history and a leader of men. It would be an impertinence for any successor in this chair to praise General Smuts ; to follow him is perforce to follow far behind. But one may congratulate the executive on the happy instinct which recognised that the occasion was unique, and so led them to an unusual—not to say a daring—choice. It was amply justified by the event. Now they have returned to the beaten track along which presidents for the most part plod, and have made a selection for which I am glad to have no responsibility.

Of General Smuts I would say one word more. His occupancy of the chair not only added to the lustre of our rejoicings : I like to think it also had a deeper significance. May we not regard it as a harbinger of the spirit of goodwill and sanity which civilisation longs for, but does not yet see ? Our hundred years of science have done sadly little towards curing the nations of mutual mistrust. Surely it was a good omen that, in marking the close of one century of achievement and the opening of another, we should have had for president a citizen of the world whose life has been a lesson in subordinating the lower patriotism to the higher good, who by example no less than by precept has taught his fellows that they should beat their swords into ploughshares and not learn war any more.

Now we revisit our birthplace well aware of our maturity. We have scored our first century and begun to compile our second with the easy assurance of a Bradman or a Hobbs. At once the question arises, Is that assurance justified by the Association's continued vitality ? Do we still give the community reason to support us ? Or are we a survival, trading on a reputation which our present activities do little to increase ? I put the question bluntly—nowadays we are all familiar with disagreeable stock-takings and shrinking values—but it need not detain us long. I am confident you will find no trace of decrepitude. It is true that the sciences included in our purview have become specialised and differentiated to a degree that would make ridiculous any claim to the qualified omniscience which was possible in our early days. It is also true that each department of science now has its own society of votaries who meet, as it were, in a masonic temple and converse in a jargon that has little if any meaning for the general ear. But these very facts make this Association the more useful. Notwithstanding the restrictions of specialism, science has its own broad outlook, demanding expression and explanation to laymen ; and more than ever is it true—far truer than it was a hundred years ago, when we were ridiculed as a hodge-podge of philosophers and made the target of an unsympathetic Press—that laymen want to have intelligent contact with the seekings and findings of the scientific mind.

I say seekings and findings rather than conclusions, for that word has too final a ring. Here we may note a striking change in the temper of the investigator. I am old enough to remember a time when some of the spokesmen of science (never, indeed, the greatest) displayed a cocksureness that was curiously out of keeping with the spirit of to-day. Among contemporary leaders nothing is more general than the frank admission that they are groping in a half-light, tentatively grasping what at best are only half-truths. Things that to one generation seemed to be essential parts of a permanent structure are treated by the next as mere scaffolding. The quest of truth goes on endlessly, ardently, fruitfully. Yet with every gain of knowledge we realise more clearly that we can never really know. To understand, as Einstein lately said, is to draw one incomprehensible out of another incomprehensible. From time to time we discover a fresh relation between observed phenomena, but each of the things which are found to be related continues to evade our full comprehension ; and that is apparently the only kind of discovery we can achieve. Our joy in the quest itself never fails ; we are constantly learning that it is better to travel than to arrive.

The philosophical implications of this altered attitude are many—indeed they concern the deepest springs of thought. What I wish at the moment to point out is that the new spirit strengthens a sense of brotherhood between the scientific adept and the average man, who in his own way is also commonly a seeker after truth. He listens gladly when the specialist drops his toga and admits that in scientific matters the only dogma is that there is no dogma. Obviously, too, the advance of science makes an increasing claim upon the layman's notice through its technical applications. It invades his home and alters his ways ; it affects almost every feature of the daily round ; it brings him interests, comforts, wealth ; it enormously enlarges his powers of work and play. Further, at a time like the present, when we carry a load of social, political, and economic discontents, the ordinary citizen doubtless reflects that if only we could apply the dispassionate temper of science to the difficulties of the hour, we might face them with less waste of effort and greater likelihood of settlement.

These are a few of the reasons why the British Association keeps its hold on the public. It links experts with one another and with laymen, to the benefit of all. Experts gain by indulging in a short interval of comparatively lucid self-expression. They gain also by trying to understand each other, which is by no means so easy as one might suppose. To meet under these happy conditions is a stimulus to everybody. An old worker in science looks gratefully back on his attendances at the British Association, not only as delightful human events but also as red-letter days in his own development, as milestones in the unceasing march of his subject, and as helps in the hard task of keeping himself more or less in step.

It is recorded that York was chosen for our birthplace because in the Yorkshire Philosophical Society the infant would secure intelligent dry-nursing at the hands of a large body of friendly amateurs. In a letter to the secretary of that Society, Sir David Brewster described the purpose of the proposed Association in the following words :

> "The principal objects would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

There, in a nutshell, is what the Association set out to do, what it may fairly claim to have done, and what it still does. If you want an illustration, you had it last year when a great audience sat for hours, with every sign of sustained attention, while the evolution of the universe was discussed by British and foreign specialists of acknowledged authority, immense learning, and conspicuous variety of opinion.

At the end of that symposium the debate was admirably summed up by Sir Oliver Lodge, the Nestor of physics, who in every sense has filled a big place in our gatherings for more than fifty years. He has taught us much : would that he could teach his secret of perpetual youth ! In a recent volume of reminiscences he tells delightfully of the meetings he has frequented and the friendships to which they have led. If he is thankful for them, so are we for him. Not a few of us have found inspiration in the fountain of his knowledge, in the spontaneity and aptness of his spoken word, in the width of his sympathy and understanding, and have learnt to love him for his large humanity.

My own first contact with these meetings antedates even that of Sir Oliver. Sixty-five years ago it chanced that the Association in its peripatetic course came, for the first time, to my native town, and I was taken, a boy of twelve, by my mother to the Section of Mechanical Science, having already announced my intention of becoming an engineer. To the pundits of Section G, we must have seemed an odd pair, the douce minister's wife and the shy little boy in his kilt. It was by my own wish, of course, that I was taken, and my mother counted no labour lost that might develop intelligence in her family of sons. The boy could not understand much of what he heard ; it was something, however, to see the leonine head of the sectional president, Macquorn Rankine, over whose engineering textbooks he was later to spend many assiduous hours. There is no boundary to a mother's dreams, but in their wildest excursion they can scarcely then have pictured what is happening in this hall to-night.

Here let me make a confession which may also serve as an apology. I have the unwelcome distinction of being the oldest president the Association has ever suffered. In its primitive years the average age of presidents scarcely exceeded fifty : one of them, aged only twenty-nine, afterwards founded the Cavendish Laboratory, and so did a service to science which it would be impossible to overvalue. As time went on, the choice fell on older men, and now the electors have taken what one hopes may be regarded as an extreme step. But, as it happens, this is not the first time I have read the president's address. At the Edinburgh meeting of 1921, the president, Sir Edward Thorpe, was prostrated by illness and asked me to act as his mouthpiece. The small service so rendered brought an unexpected reward. Some newspaper report must have confused the platform substitute with the real president, for a well-known novelist sent me a copy of one of her romances, which was no doubt meant as a tribute to Sir Edward. It was called " The Mighty Atom "—an arresting title. Perhaps that is why I did not read beyond the title-page. Without close examination, it was put by a more orderly hand than mine on a shelf that already held works on like subjects by authors such as J. J. Thomson and Rutherford and Bohr. " The Mighty Atom " was said to be one of the best sellers of its day : in that respect, if in no other, it found congenial company when it was joined on the same shelf by a series of volumes from the fascinating pens of Eddington and Jeans. These, however, I need not tell you, I have read and re-read, to my entire pleasure and partial understanding.

Atomic Physics

If " The Mighty Atom " was an arresting phrase, it was also an apt one. For we now know the atom to be indeed mighty in senses that were little suspected by the begetters of atomic theory. It has been mighty in sweeping away ideas that were found inadequate, in demanding fresh concepts, in presenting a new world for conjecture and experiment and inference, in fusing chemistry and physics into a single science. It is found to be mighty in the complexity of its structure and the variety of radiations it may give out when excited to activity. It has unravelled for us the bewildering tangle of spectroscopic lines ; and, most surprising of all, the atom, however seemingly inert, is mighty in being a magazine of energy which, for the most part, it locks safely away. This is fortunate, for if the secret were discovered of letting loose the atomic store, we should invite dissolution at the hands of any fool or knave. It is also fortunate that in the furnace of the sun, at temperatures far higher than those of our hottest terrestrial infernos, the stored energy of the atom is drawn upon, as we believe, and has been drawn upon for ages, to keep up that blessed radiation which makes man's life possible and is the source of all his power.

In the middle 'nineties there set in an astonishing renaissance of physical science, which has centred in the study of the atom and extends by inevitable logic to the stars. In quick succession came three great discoveries : the X-rays by Röntgen in 1895, radioactivity by Becquerel in 1896, and the electron by J. J. Thomson in 1897. Sensational, puzzling, upsetting, these events inspired every physicist to new activities of thought and equipped every laboratory with no less novel methods of research. A flood of further discovery followed, the flow of which continues unabated. Within the last few months notable items have been announced that well deserve our attention. It may not be inappropriate if I try for a few minutes to touch—however lightly—on one or two aspects of this subject, as it is seen through the eyes of an engineer.

Thanks mainly to J. J. Thomson, Rutherford, and Bohr, we now recognise the atom of any substance to be a highly complex structure, built up, so to speak, of two sorts of blocks or brickbats—the electrons, which are indivisible units of negative electricity, and the protons, which are indivisible units of positive electricity. It is strangely simple to be taken back, as it were, to the nursery floor and the childish game, and given just two sorts of blocks, exactly alike in each sort, and exactly the same number of each sort, with which to build the universe of material things. The blocks are unbreakable: we cannot produce them or destroy them or change them. In respect of electrical quality the two kinds are equal and opposite, but they contribute very unequally to the atom's mass, each proton (for some reason not yet understood) contributing about 1840 times more than each electron. Every substance is made up of blocks of the same two sorts. If you compare different substances you find that the diversity of their chemical and other properties arises solely from differences in the number and arrangement of the blocks which compose their atoms. Any atom, in its normal or electrically neutral state, must contain an equal number of protons and electrons.

All the protons in any atom are gathered close together at the centre, along with some of the electrons, forming a compact, dense portion which is called the nucleus. Although the nucleus accounts for nearly the whole of the atom's mass, it occupies no more than a very minute fraction of the atom's volume. Those of the electrons which are within the nucleus doubtless serve to bind the protons together; the other electrons constitute, as it were, a voluminous crinoline, or rather a series of crinolines, extending relatively far away from the centre and giving the whole atom an exceedingly open structure. Within that open structure upheavals may be caused by outside agents in various ways. One or more of the electrons in the crinoline may be temporarily removed (as, for example, by the action of heat or by the incidence of energetic radiation), and the atom is then said to be ionised: for a time the balance between positive and negative is upset. But the missing electron returns to its place, or another comes instead, and when this happens a definite amount of radiation is given out, much as energy is given out when a weight falls from one to another landing of a staircase. We may speak of the landings as energy levels. The radiation which issues when an electron falls from one energy level to another constitutes what is called a photon.* It has two aspects, behaving in one like a particle and in the other like a group of waves, and at present we have to accept both though we cannot fully reconcile them. The photon carries a definite quantity of energy and is characterised by a definite frequency of vibration. Its energy depends on the two levels between which the electron falls, and this determines the frequency of the vibration which the photon conveys, for the frequency is equal to the energy divided by that mysterious constant of Nature, the quantum of action discovered by Planck. In any element all the atoms have the same set of energy levels; these contribute to the emission spectrum and account for its groups of spectral lines. In heavy atoms there are many energy levels, and consequently very many lines appear in their spectra.

What we have to realise is that all matter consists of the two kinds of electricity, protons and electrons, held apart we do not know how. To the early experimentalists who electrified rods of resin or glass by rubbing them, electricity seemed no more than a curious attribute of matter; now we regard it as matter's very essence—the ultimate stuff out of which every atom is built. If you ask, What is electricity? there is no answer, save that it is a thing which exists in units of two sorts, positive and negative, with a strong attraction for each other, and that in any atom you find them somehow held apart against that attraction, with a consequent storing of potential energy. They are prevented from coalescing, although the difference of potential between them is nearly a thousand million volts. Why they do not flash together is a mystery—one of the many mysteries which physicists have still to solve.

Engineers are accustomed to the idea of storing energy in a condenser by charging the opposed plates to a potential of a few scores or hundreds or thousands of volts. That is done by transferring some of the crinoline electrons from one to the other plate: it involves only a minute supplementary separation, which disappears when the condenser is discharged. In every atom we have a permanent separation of electricities; the protons and electrons look at one another, so to speak, across an immensely greater dielectric gulf which no laboratory operation ever causes them to bridge. That is why every atom is a magazine of energy, the quantity of which (mc^2) is proportional to the atom's mass.

Any of the usual operations of the electrical engineer, such as charging and discharging a condenser or a storage battery, or driving a dynamo

* We owe the name 'photon' to Prof. G. N. Lewis, of Berkeley, California, who proposed it in a letter published in NATURE of Dec. 18, 1926.

and conducting electricity from it to a distant station where it can actuate a motor or heat the filaments of lamps to incandescence, may be described as the setting up and the breaking down of a comparatively small extra difference of potential between the opposed electricities in some of the atoms of the engineering plant. In every process of industrial electricity, on whatever scale, what happens is a temporary enlargement of the potential difference which always exists between electrons and protons, and then a return to what may be called Nature's *status quo*. But those supplementary differences of potential which the engineer first superimposes and then allows to disappear are exceedingly small, even at their greatest, in comparison with the gigantic difference which the normal condition of the atom itself involves.

A notable event of the year is the strong evidence which Dr. J. Chadwick, of the Cavendish Laboratory, has found for the existence of what is called the neutron—a type of particle in which an electron and a proton are associated in particularly close juxtaposition. There is a like close association between electrons and protons in the nucleus of any heavy element, but it had not previously been discovered in a single isolated pair. Twelve years ago Lord Rutherford conjectured the existence of such a particle, and described the properties it should possess. Its excessive smallness and density, together with its lack of an external electric field, give it a unique power of penetrating matter. It is too slim to be confined under pressure in any vessel : it will simply slip through the walls. The normal hydrogen atom has the same two constituents, one proton and one electron, but in nothing like the same intimacy of association, for the hydrogen atom wears its electron as a bulky crinoline which confers on it an immensely greater volume. The neutron, on the other hand, may be said to have taken the crinoline off, folded it up, and put it in its pocket. Not to be too fanciful, we may at least describe the partners as clasping one another so tightly that the electron has ceased to be a fender ; none the less, as a unit of negative electricity it still serves to give electrical balance to the pair. Though so close together, the two constituents of the neutron remain separate and distinct, parted by nearly as many million volts as in a hydrogen atom. In this hitherto unknown particle, the existence of which the experiments of Dr. Chadwick seem definitely to have proved, we have a new physical entity of extraordinary interest and a powerful tool for further research.

Lord Rutherford was the first to discover and name the nucleus. It is the inner sanctuary of the atom, the repository of secrets many of which have yet to be disclosed, almost unapproachable, not only because of its smallness but also because of the electric field in which it is encased. Recognising the nucleus to be a richly charged strong-room, Rutherford has spared no effort to break it open. He has submitted it to a furious bombardment, using as missiles the α-particles which radioactive substances project. These particles, each consisting of four protons and two electrons compactly built together, have the necessary velocity and energy to penetrate to the atom's heart. Rutherford had perforce to fire into the ' brown ' : he could not aim his gun, nor even tell when it would go off : the chances of a hit were no more than one in many millions. But hits were in fact obtained —hits so effective that they chipped off protons and caused the missiles to be absorbed, thus realising the dream of the alchemist by making one element change into another. That was a dozen or more years ago : since then his attack has lost none of its severity. It has been taken up under his guidance by a school of workers, and many further secrets of the nucleus have been revealed.

Quite recently two of his disciples have gone one better, as disciples sometimes do, to the joy of their lords. Dr. J. D. Cockcroft and Dr. E. T. S. Walton have used missiles of their own making instead of those that come spontaneously and intermittently from substances such as radium or thorium. By beautiful devices they have applied their knowledge of electrical engineering and their mastery of electrical technique to project single protons into the nucleus of lithium, using a steady potential of several hundred thousand volts to give the projectile sufficient penetrating power. An atom of lithium has (usually) seven protons and four electrons in its nucleus ; the other three electrons constitute the crinoline. Here again it was a case of firing into the ' brown ' : out of millions of shots a few reached their billet. When the projected proton forces an entry into the lithium nucleus it creates a domestic disturbance of the liveliest kind. For with the seven protons already in occupation it makes an eighth ; the group then splits into two sets of four, each taking two of the electrons, and they fly violently apart with an energy drawn from the atomic magazine. The result is that two helium atoms are formed. This is a notable achievement, the first artificial splitting of the atom by a laboratory process in which there is no recourse to the violent projectiles which radioactive substances provide. It has been followed up by successfully applying the same method to break up the atoms of other elements.

It is a satisfaction to learn that in all the encounters and emissions and absorptions that are studied among atoms and photons and the parts of atoms there is, so far as we yet know, strict compliance with the accepted principles of conservation in respect of momentum and energy and mass, though matter (in the ordinary sense) is liable to transformation into energy and energy into matter. When radiation is emitted some matter disappears, for the atom that emits it loses a little of its mass ; when radiation is absorbed, a like quantity of matter comes into being.

But the engineer finds himself obliged to admit that no mechanical model of the atom can be expected to give an adequate picture of that strange new world. Our mechanical ideas are derived from the study of gross matter, which is made up of vast aggregates of atoms, and any model must share the limitations this implies. It is futile to explain the constitution of the atom in terms applicable to gross matter, just as it would be futile to study the psychology of an individual by observing only the movements of crowds. So we must expect to find within the atom and among its parts qualities and actions different in kind from those we know, and paradoxes which, without a wider vision, we cannot interpret. Such a paradox indeed confronts us at the present time, when we try to harmonise the wave aspect and the particle aspect of the photon, of the electron, and indeed of matter itself. These things are still a mystery—a riddle which some day we may learn to read. Meanwhile we do well to remember that any attempt to portray the structure of the atom in the language of ordinary experience is to give undue significance to symbols and analogies that are more or less invalid. Qualifying phrases like 'so to speak' or 'as it were' cannot be escaped. They are confessions that the image is inevitably a distortion of the reality it is intended to suggest.

Advancement of Science by the British Association

Let us now glance back to the early days of the Association, and trace a little—a very little—of what it has done for the advancement of science, both pure and applied. The two inevitably march together. Between discovery and invention there is, in effect if not always in form, a close partnership with a constant interchange of advantage. No discovery, however abstract, is safe from being turned to practical account ; on the other hand, few, if any, applications fail to react in stimulating discovery and providing the experimentalist with more effective weapons of attack.

From the first the Association took cognisance of engineering as one of the subjects it was created to advance. One of its earliest acts, and a very wise one, was to invite reports on the state of science : these were called for in many different fields and were written by the best available experts. In the first batch of such reports were two that dealt with engineering, one on the strength of materials and the other on hydraulics. As it happened, they were of very unequal merit ; but they are alike in this, that they demonstrate how conspicuous was the lack of science on the part of early British engineers.

The engineers of those days were big professional figures. They had covered the country with a network of roads and bridges and canals ; they had drained the fens ; they had built harbours and lighthouses. By multiplying factories, by extending the uses of coal and iron, they were laying the foundations of that commercial supremacy which, so long as it lasted, we took for granted as a sort of national right. They had taught the world how to light towns by gas, and were beginning to drive ships by steam. Above all, they had shown that a new era of locomotion was about to set in. A railway connecting Liverpool with Manchester had been opened : its success was proved, and schemes were projected that would soon utilise labour on a large scale for a host of tunnels and cuttings and embankments, and so relieve the scourge of unemployment which—as we also know—follows the scourge of war. The engineering pioneers were sagacious men who put their faith in experience ; they knew little of theory and cared less. Instinct and personality carried them through difficulties of a kind that science might have helped them to solve or to avoid. They had the sense to profit by their own mistakes.

It is significant that in 1832, when the British Association called for a report on the present state of our knowledge of hydraulics as a branch of engineering, the terms of reference included this curious phrase : "Stating whether it appears from the writings of Dutch, Italian, and other authors that any general principles are established on this subject".

The report was written by George Rennie, a son of the greater Rennie who left us a monument of his genius—I wish I could say an imperishable monument—in Waterloo Bridge. After giving a good summary of the work of foreign theorists the reporter remarks :

" It only remains for us to notice the scanty contributions of our own countrymen. While France and Germany were rapidly advancing upon the traces of Italy, England remained an inactive spectator of their progress."

It is clear that there was much need for the scientific leaven which the new Association could, and did, provide.

Another of the early concerns of the Association was with the performance of steam-engines. At the date of our foundation, more than fifty years had passed since the inventions of Watt provided an engine fit to serve as a general means of producing power. Its earliest application, and still at that date its most common one, was in the pumping of mines. Engineers took a professional and even sporting interest in what they called its 'duty', meaning the amount of water pumped through a given height for each bushel of coal consumed. Nevertheless it is a remarkable fact that neither they nor the physicists of that period had any notion that the process involved a conversion of heat into mechanical work.

It is difficult for us now to imagine a world of physics and engineering where the idea had not yet dawned that there was such a thing as energy, capable of Protean transformations, but in all of them conserving its total amount. Enlightenment was soon to come, and our meeting-rooms furnished the scene. In 1843 Joule brought before one of the sections his first determination of the mechanical equivalent of heat. He spoke with the modesty natural—in those days—to a man of twenty-four. His paper was received in chilly silence. Two years later, after further experiments, he reappeared ; but again no notice was taken of the heresies of a youthful amateur. Nothing daunted, he prepared a fuller case for the Oxford meeting of 1847, perhaps remembering that Oxford is the home of lost causes. In a narrative written many years later, Joule has told how the chairman suggested that, as the business of the Section pressed, he should not read the paper, but merely give a brief account of his experiments :

" This [he says] I endeavoured to do, and discussion not being invited, the communication would have passed without comment if a young man had not risen in the Section and by his intelligent observations created a lively interest in the new theory. The young man was William Thomson."

But Thomson, though deeply interested, was not at first convinced. Nearly four years more were to pass before he satisfied himself that the doctrines of Joule did not clash with the teachings of Carnot, of which he was then an enthusiastic proselyte. At length he became a convert ; he saw, as we should now say, that the First Law of Thermodynamics was in fact consistent with the Second. Then indeed he accepted the principles of Joule in their entirety and was eager in their support. Quickly he proceeded to apply them to every part of the physical domain. Along with Clausius and Rankine, he formulated the principles which govern the whole art of producing power by the agency of heat. The steam turbine of Parsons, the gas-engines of Otto and Dugald Clerk, the oil-engines of Daimler and Diesel, with all their social consequences in making swift travel easy by road and possible by air, are among the practical results. On the same thermodynamic foundation was built the converse art of mechanically producing cold, which we employ in ever-increasing measure for the import and storage of our food. Joint experiments undertaken by Joule and Thomson led to a further discovery, which later enabled the process of refrigeration to be carried very near to the limit of coldness which Thomson himself established as the absolute zero. In the hands of Linde and Claude the Joule-Thomson effect as a means of producing extreme cold has created new industries through the liquefaction of air and the separation of its constituents by methods of fractional distillation. However cold, however near the absolute zero, was the Association's first reception of Joule, we may claim that in effecting a conjunction between him and Thomson it made amends. Their meeting in 1847 ushered in a new era both of scientific theory and of engineering practice.

Of the Association's many other services there is little time to speak. When the telegraph developed in the middle of last century and spread itself across the Atlantic, largely under the guidance of that same William Thomson (whom later we knew as Lord Kelvin), there were no accepted units in which electrical quantities could be measured and specified. The scientific world was as badly off then for a standard of electricity as the commercial world is now for a standard of value. The need of electrical standards was urgently felt, by none more than Thomson himself. He stirred the Association to act : a strong committee was set up, and in time its work served as a basis of international agreement. There is no danger that any country will wish to ' go off ' the standards thus established. To settle them was an incalculable boon to science no less than to technics. It paved the way for the revolution of the eighteen-eighties, when electricity passed, almost suddenly, from being no more than the servant of the telegraph to be master of a great domain. It was then that the electric light and the electric transmission of power gave it a vastly extended application, and the fundamental discoveries of Faraday, the centenary of which we lately celebrated, came into the kingdom for which they had waited nearly fifty years.

Another notable achievement of the Association was to promote the establishment of a National Physical Laboratory. Informal talks at our meetings in the 'nineties led to the appointment of a committee which moved the Government of the day to take action. The Laboratory was constituted, and Sir Richard Glazebrook was appointed its first head. What it has become in his hands and the hands of his successor, Sir Joseph Petavel, does not need to be told. From small beginnings it has grown to be an influential factor in the world's scientific progress, and a legitimate subject of national pride.

Another by-product of quite a different sort is the memorial to Charles Darwin which we hold as trustee of the nation and of all nations. At our meeting in 1927 the president, Sir Arthur Keith, spoke in his address of the house where Darwin lived and worked, pointing out how admirably it would serve as a monument of the great naturalist. No sooner was the suggestion published than a donor came forward, whose devotion to the memory of Darwin expressed itself in a noble gift. Sir Buckston Browne not only bought and endowed Down House, but also arranged with pious care that the house and its grounds should exhibit, so far as was possible, the exact environment of Darwin's life. The pilgrims who now visit this shrine in their thousands see Darwin's study as it was when the master thought and wrote, and can reconstruct the habit of his days. There could not be a more appropriate memorial. Its custody by the Association involves obligations which are by no means small, and we may claim that they are worthily fulfilled.

One may safely say that there is no department of scientific endeavour our meetings have not aided, no important step in the procession of discovery they have not chronicled. It was at our meeting of 1856 that Bessemer first announced his process of making a new material—what we now call mild steel—by blowing air through melted pig iron. Produced in that way, or by the later method of the regenerative furnace and the open hearth, it soon revolutionised the construction of railways, bridges, boilers, ships, and machinery of all sorts, and it now supplies the architect with skeletons which he clothes with brick and stone and concrete. It was at the Oxford meeting of 1894 that Lodge demonstrated a primitive form of wireless telegraph based on the experiments of Hertz, a precursor of the devices that were brought into use a little later through the practical skill and indefatigable enterprise of Marconi.

At the same meeting there was an epoch-making announcement by the late Lord Rayleigh. His patient weighings of the residual gas which was found after depriving air of all its oxygen led him to the discovery of argon. That was a surprise of the first magnitude ; it was the herald, one may say, of the new physics. Next year his colleague, Ramsay, presented other members of the family of inert gases. It is curious to recall the indifference and scepticism with which these really great discoveries were received. Some of the chemists of that day seem to have had no use for inert gases. But the stones which the builders were at first disposed to refuse are become head stones of the corner. In the architecture of the elements they fill places that are distinctive and all-important ; they mark the systematic sequences of the periodic law. In a metaphor appropriate to atomic physics we may describe them as coy ladies with a particular symmetry in their crinoline of electrons, unresponsive to advances which other atoms are ready to make or to receive. Inert though they be, they have found industrial uses. Helium fills airships ; argon fills incandescent lamps ; and neon, so modest a constituent of the atmosphere that you might think it born to blush unseen, has lately taken to blushing deliberately and even ostentatiously in the shop-signs of every city street. In the field of pure science it was neon, outside the radioactive elements, that first introduced us to isotopes ; and helium has a greater glory as the key to radioactive transformations and historian of the rocks. Disciples of evolution should be grateful to helium for delivering them from the cramping limits of geological time which an earlier physics had mistakenly imposed.

My own recollection covers many surprises that are become commonplaces to-day : the dynamo, the electric motor, the transformer, the rectifier, the storage battery, the incandescent lamp, the phonograph, the telephone, the internal combustion engine, aircraft, the steam turbine, the special steels and alloys which metallurgists invent for every particular need, wireless telegraphy, the thermionic valve as receiver, as amplifier, as generator of electric waves. To that last we owe the miracle of broadcasting. Who, a generation ago, would have imagined that a few yards of stretched wire outside the window and a magic box upon the sill could conjure from adjacent space the strains of Beethoven or Bach, the exhortations of many platforms, the pessimism natural to those who forecast the weather, and the optimism of orators who have newly dined ?

> " Sounds and sweet airs, that give delight and hurt not.
> Sometimes a thousand twangling instruments . . .
> And sometime voices . . . that, when I waked,
> I cried to dream again."

I know no product of engineering more efficient than that magic box. It needs no attention ; it is always ready for service ; and when you tire of it you have only to switch it off. A blessing on it for that ! Heard melodies may be sweet, but those unheard are often sweeter. Do you ever reflect, when you pick and choose among the multitude of airs and voices, or shut out all from your solitude of thought, that they are still there, physically present, individual, distinct, crowding yet not interfering, besetting you though you do not perceive them, silent until you determine that one or another shall catch your ear ? Go where you will, to the ocean or the wilderness or the pole, you cannot escape that vast company of attendants ; they come to you, unheard, unseen, from every quarter of the globe with a swiftness no other messengers approach. Is any fairy tale so strange as that reality ? In all the wizardry of science surely there is nothing more wonderful than this.

Discovery and the Future of Mankind

Among the inventions which have revolutionised the habits of modern man some were developed by steps that were mainly empirical. Others, especially those that are most recent, have had a very different history : science has been their incubator and their forcing-house. In the advance of any invention there is bound to be an element of trial and error, but when the scientific method is consistently applied the proportion of error is small and progress is swift. We see this exemplified in the development of mechanical flight, where one difficulty after another has been vanquished by aid of well-directed theory and well-related experiment. Or consider that immensely important modern art, the art of communication by telegraph and telephone, by wire and ' wireless '. There the efforts of scientific engineers were dominant at every stage, and it was through their guidance that the art quickly achieved its world-wide triumphs. It is true that in the story of long-distance radiotelegraphy there was a striking episode where the courage of the practical inventor forestalled the discovery of a recondite scientific fact. It happens that the wireless waves from a radio-station, instead of shooting out straight into space as such rays might be expected to do, become bent in the upper regions of the atmosphere, taking a surprising and convenient curvature which enables them to travel round the surface of the globe. An unlooked for kindness on the part of Nature has provided what we now call the Heaviside layer by which she works this happy trick. The strange fact that the rays could somehow bend was recognised and applied by Marconi before anybody had a rational explanation to suggest. Speaking broadly, however, it was scientific nursing of the infant art, and scientific culture throughout its period of growth, that brought it to the splendid manhood which now blesses mankind.

I think we may regard the whole art of electrical communication as an unqualified blessing, which even the folly of nations cannot pervert : in that regard it differs conspicuously from some other inventions. Before it came into use the sections of civilised man were far more separate than they will ever be again. There could be scant sympathy or understanding, little chance of effective co-operation among communities scattered over the earth. A calamity might fall on one and be already old before others knew of it to offer help. Now we have all the world made practically instant in its interchange of thought. Through this physical linkage, which annihilates both space and time, there is opened a possibility of quick discussion, common resolution, simultaneous action. Can you imagine any practical gift of science more indispensable as a step towards establishing the sense of international brotherhood which we now consciously lack and wistfully desire ? Should that aspiration ever become more than a dream we shall indeed have cause to bless the creators of electrical communication, to praise them and magnify them for ever.

In the present-day thinkers' attitude towards what is called mechanical progress we are conscious of a changed spirit. Admiration is tempered by criticism ; complacency has given way to doubt ; doubt is passing into alarm. There is a sense of perplexity and frustration, as in one who has gone a long way and finds he has taken the wrong turning. To go back is impossible : how shall he proceed ? Where will he find himself if he follows this path or that ? An old exponent of applied mechanics may be forgiven if he expresses something of the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to take unbounded delight. It is impossible not to ask, Whither does this tremendous procession tend ? What, after all, is its goal ? What its probable influence upon the future of the human race ?

The pageant itself is a modern affair. A century ago it had barely taken form and had acquired none of the momentum which rather awes us to-day. The Industrial Revolution, as everybody knows, was of British origin ; for a time our island remained the factory of the world. But soon, as was inevitable, the change of habit spread, and now every country, even China, is become more or less mechanised. The cornucopia of the engineer has been shaken over all the earth, scattering everywhere an endowment of previously unpossessed and unimagined capacities and powers. Beyond question many of these gifts are benefits to man, making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gifts have been and may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty. In the slow evolution of morals he is still unfit for the tremendous responsibility it entails. The command of Nature has been put into his hands before he knows how to command himself.

I need not dwell on consequent dangers which now press themselves insistently on our attention. We are learning that in the affairs of nations, as of individuals, there must, for the sake of amity, be some sacrifice of freedom. Accepted predilections as to national sovereignty have to be abandoned if the world is to keep the peace and allow civilisation to survive. Geologists tell us that in the story of evolution they can trace the records of extinct species which perished through the very amplitude and efficiency of their personal apparatus for attack and defence. This carries a lesson for consideration at Geneva. But there is another aspect of the mechanisation of life which is perhaps less familiar, on which I venture, in conclusion, a very few words.

More and more does mechanical production take the place of human effort, not only in manufactures but also in all our tasks, even the primitive task of tilling the ground. So man finds this, that while he is enriched with a multitude of possessions and possibilities beyond his dreams, he is in great measure deprived of one inestimable blessing, the necessity of toil. We invent the machinery of mass-production, and for the sake of cheapening the unit we develop output on a gigantic scale. Almost automatically the machine delivers a stream of articles in the creation of which the workman has had little part. He has lost the joy of craftsmanship, the old satisfaction in something accomplished through the conscientious exercise of care and skill. In many cases unemployment is thrust upon him, an unemployment that is more saddening than any drudgery. And the world finds itself glutted with competitive commodities, produced in a quantity too great to be absorbed, though every nation strives to secure at least a home market by erecting tariff walls.

Let me quote in this connexion two passages from a single issue of the *Times* (June 25, 1932). In different ways they illustrate the tyranny of the machine. One is this :

> "The new Ford works built upon a corner of Essex . . . will soon be able to produce motor-cars at the rate of two a minute."

The other comes from Moscow. It also relates to the mass-production of motor-cars, and indicates how Russia is reaching out towards a similar perfection under the austere stimulus of the Five Years' Plan :

> "The Commissar lays down dates for the delivery of specified quantities by each factory and invests twenty-one special directors with extraordinary powers to increase production, threatening each director with personal punishment if deliveries are belated."

We must admit that there is a sinister side even to the peaceful activities of those who, in good faith and with the best intentions, make it their business to adapt the resources of Nature to the use and convenience of man.

Where shall we look for a remedy ? I cannot tell. Some may envisage a distant Utopia in which there will be perfect adjustment of labour and the fruits of labour, a fair spreading of employment and of wages and of all the commodities that machines produce. Even so, the question will remain, How is man to spend the leisure he has won by handing over nearly all his burden to an untiring mechanical slave ? Dare he hope for such spiritual betterment as will qualify him to use it well ? God grant he may strive for that and attain it. It is only by seeking he will find. I cannot think that man is destined to atrophy and cease through cultivating what, after all, is one of his most God-like faculties, the creative ingenuity of the engineer.

Summaries of Addresses of Presidents of Sections*

Physics in the Search for Minerals

PROF. A. O. RANKINE, in his presidential address to Section A (Mathematical and Physical Sciences), entitled " Some Aspects of Applied Geophysics ", reviews the development of geophysical prospecting, a practical application of physics which, although originating abroad, has during recent years attracted some attention in Great Britain. The subject is a border-line one between physics and geology, and the complications usually displayed by the underground structures sought demand the combined efforts of physicists and geologists, if reliable results are to be obtained.

It is necessary to distinguish between methods based on definite physical principles and those commonly called ' divining '. Without necessarily condemning the latter, they must be excluded from discussion, since the *modus operandi* is unknown. A geophysical method, properly so-called, must have as its basis the differentiation of some recognised physical property as between rocks, such as density, elasticity, magnetic susceptibility, or electrical conductivity. It involves measuring on or near the earth's surface, by means of suitable apparatus, the physical effects associated, either naturally or through artificial stimulation, with such variations of physical properties.

In dealing first with the gravitational method, a special tribute is due to the work of Baron von Eötvös, the pioneer of geophysical prospecting. The Eötvös torsion balance, designed in the first instance for purely geodetic work, is an instrument of amazing performance. While rendering it robust enough for field work, Eötvös managed to preserve a sensitivity sufficient to allow measurement of gravitational non-uniformities so small as those arising from the rotation of the earth on its axis. The use of such an effective device in investigating density differences of underground formations seems now to be obvious, but it was not until comparatively recently that Eötvös, under the persuasion of the geologist, Prof. de Böckh, agreed, somewhat reluctantly, to turn his attention to problems of economic importance. As a result, the gravitational method of prospecting has since been used very widely. Its principal achievements have been the location and delineation of salt domes with which oil is associated.

The seismic method, although not yet based on so sure a foundation as the gravitational method, has been practised widely on account of its greater celerity, and under conditions which exclude effective use of the torsion balance. As regards the magnetic method, with the portable magnetometers at present available, the method is practically limited to the detection of rocks rich in ferromagnetic material. If the sensitivity of magnetometers could be improved to a degree comparable with that of the Eötvös balance, the scope would be greatly extended; work, therefore, on these lines seems to be desirable.

After a short reference to electrical methods, Prof. Rankine concludes with an appeal for the continuation and extension in Great Britain of research work in the various branches of this comparatively new and difficult subject.

* The collected presidential addresses delivered at York are published under the title "The Advancement of Science, 1932", price 3*s*. 6*d*.

Stereochemistry of Living Matter

In his presidential address to Section B (Chemistry) Dr. W. H. Mills considers " Some Aspects of Stereochemistry ". Referring to the electron theory of valency, he explained how, by assigning a stereochemical interpretation to the valency octet, a rule can be obtained which gives an approximate indication of the relative directions of the valencies in compounds to which the octet theory applies. He showed that the ' tetrahedral octet ' provides a simple interpretation of the Walden inversion in certain classes of reactions, and that it enables an explanation to be given of the readiness with which *trans*-elimination is effected. He showed also that in the Beckmann transformation, *trans*-migration of the groups is inherently more probable than *cis*-migration.

Dr. Mills devotes the latter part of his address to the problem of the optical activity of living matter. He points out the bearing on this question of the stereospecificity of reactions between molecularly dissymmetric compounds: an optically active substance reacts with unequal velocities with the *d*- and *l*-forms of a dissymmetric compound. Since vegetable organisms can convert their inorganic food-stuffs into optically active compounds, the reactions involved in vital processes must be highly stereospecific. In living matter we find every dissymmetric component present in one configuration only, and these configurations are so correlated that each component encounters that antimer only of its co-reactants with which it interacts the more rapidly. It is evident that living matter thus constituted must be more efficient than a hypothetical tissue in which every dissymmetric component is present in its racemic form.

If we imagine a form of living matter composed of inactive materials, it would consist—by reason of the stereospecificity of vital reactions—of two more or less independent systems working side by side. One of these systems—' the *d*-system '— would include those forms of dissymmetric vital products found in Nature, such as *d*-glucose and *l*-leucine. Working alongside this there would be the enantiomorphous *l*-system. In the growth of vegetable tissue composed of such inactive living matter the *d*-system would be producing the components of the new tissue of the configurations found in Nature, and the *l*-system would be producing their enantiomorphs at an equal rate, and the new tissue would be optically inactive. In a tissue in which one of these systems is in excess, their rates of increase will be unequal. The relative proportions of the components of the two systems in the new tissue will be determined by the complicated laws which connect their rates of production with the concentrations of their generators in the old tissue.

The components of the new tissue will be built up from the food-materials by chains of synthetical reactions, and the rates of formation of the end-products will be controlled by the velocity of the slowest links in the chains. If we imagine a case in which the slowest link is a bimolecular reaction proceeding at a rate proportional to the concentrations of the two reactants, and suppose that the old tissue contained *twice* as much of the *d*- as of the *l*-system, there would be *four times* as much of the *d*- as of the *l*-product in the new growth. We cannot suppose that the relations are so simple as this, but so long as the velocities of the bi- and polymolecular reactions concerned in growth increase with concentration more rapidly than according to the first power (and it seems likely that they will), any excess of one system over the other in the old tissue will become greater in the new growth. An optically inactive growing tissue will then be, in respect of its optical inactivity, in unstable equilibrium. If there is the slightest departure in either direction from exact equality of the *d*- and *l*-components of the tissue, this inequality will increase with growth continuously according to a compound interest law, until eventually the system originally in defect will be completely swamped by the enantiomorphous system.

Given a slight initial bias, an association of complex organic substances which has the property of increasing itself indefinitely at the expense of inorganic substances must necessarily become optically active. If the initial quantity of the association be sufficiently small, the existence of the bias can be accounted for by the laws of probability.

Human Industries and the Ice Age

In the first part of his presidential address to Section C (Geology), entitled " The Contacts of Geology : The Ice Age and Early Man in Britain ", Prof. P. G. H. Boswell discusses the training of geologists, and comments on the handicap under which present-day students of geology commence their university careers.

The second and longer part of the address deals with the ice age and early man in Britain. A review of the evidence of successive glaciations and of the intervening episodes makes it clear that a provisional correlation with early human industries can now be attempted satisfactorily. The sequence of these industries, as also of the deposits with which they are associated, is most complete in East Anglia, and the deposits of this area may therefore be appropriately selected as the standard for Britain. This standard succession may be summarised thus: Pre-Chellian and possibly Early Chellian industries, followed by the First Glaciation (Scandinavian Drift, Norwich Brickearth, etc.) ; First Interglacial interval, lengthy but cold, with extensive valley erosion, human industries doubtful ; Second Glaciation (Great Chalky Boulder Clay) ; Second Interglacial interval, warm, lake-like deposits of Hoxne, Ipswich, etc., valley aggradation and terrace formation, re-arrival of *Corbicula fluminalis*, human industries ranging from Acheulian and Clactonian to Early Mousterian (Levalloisian) ; Third Glaciation (Upper Chalky Drift, Trail and Coombe Rock) ; Third Interglacial interval, uplift and valley erosion, Middle to Late Mousterian, and Early to Middle Aurignacian ; Fourth Glaciation (Hunstanton Brown Boulder clay), probably Magdalenian.

This succession may be followed through Lincolnshire to Yorkshire and Durham, where the four glacial episodes are indicated by the Basement Till of the coast, the Lower Purple Boulder Clay, the Upper Purple Boulder Clay, and the coastal Hessle Boulder Clay. The Kelsey gravels, containing *Corbicula fluminalis*, appear to lie between the Lower and Upper Purple Boulder Clays. The upper part of the succession is traceable also into Northumberland. As a result of the work of the Geological Survey and of Raistrick and other investigators, the glacial deposits of the Lake District and the southern Scottish ice advances can be linked up with those of the country east of the Pennines. The advance of the Lake District and Scottish ice into the Irish Sea region and Cheshire plain enables correlation to be made with the Aurignacian deposits sealed in the caves of North Wales, and also with the sequence of events, described by Wills, which accompanied the diversion of the Severn drainage by way of the Ironbridge Gorge. Thus is established a link with the terraces of the lower Severn and its tributaries. The work of Dr. Mabel Tomlinson shows the connexion, via the Moreton Gap, between the deposits of the Avon-Stour system and those of the upper Thames, investigated by Sandford. Correlation can also be effected, though not without difficulty, between the physical and climatic episodes and human industries of the upper Thames and of the lower Thames, concerning which Dewey and Dines have provided useful data.

In general, the relationships of the various human industries to successive glaciations in Britain, as interpreted by reference to a standard succession, show much more agreement than might have been expected.

The Basic Nature of Systematics

The Right Hon. Lord Rothschild has devoted the greater part of his life to the study of species, and, realising that " knowledge begins with the observation of phenomena, not with experiment ", he uses many of these observations and those of other systematists to emphasise the importance of systematics, in his presidential address to Section D (Zoology), entitled " The Pioneer Work of the Systematist ".

The animal world, which appears almost infinite in the number of different forms, presents a picture of life confusing in its endless variety. Yet there is orderliness underlying this seeming confusion, and it is the task of the systematist to discover it and sort out the multitude of organisms accordingly. At the time of Linnæus this was comparatively easy (his " Systema Naturæ " contains fewer than 4300 species); but to-day the task is much more difficult, for not only are many more species already known and being discovered, but a much deeper knowledge of morphology and bionomics is also required. Besides this, the systematists' views have profoundly changed. At the time of Linnæus, marked individual differences were diagnostic of a species, and a species was considered constant. To-day, however, a great range of variability in organisms is known to exist. So profound is this phenomenon that the present-day systematist does not look upon similarity as necessarily meaning relationship, neither does dissimilarity necessarily mean specific distinctness. Variability is an essential character of everything alive; instead of species being constant, they are flexible. For example, the number of specimens of the commonest British mouse-flea (*Ctenophthalmus agyrtes*) required in order to have one pair exactly alike would be several million billions, certainly in excess of the whole flea population of Great Britain. This is tantamount to stating that no two fleas are alike.

The systematist is a direct necessity to defensive and applied biology. Applied biology can only be a science if based on sound systematics. This is evinced in all branches of botany and zoology, especially in their applied aspects, such as entomology and parasitology. The help which the systematist can extend to biology, however, is for him only a side-issue; he is a student of pure science, the driving force in his study of systematics being the irresistible attraction which the subject has for him.

Description, identification, and classification of new species are not the ultimate aim of the systematist; they are merely preliminary. A natural classification is based on blood-relationship, and thus an inquiry into evolution is entailed. Hence systematics involve not only the static study of form but also the dynamic study of development and evolution. A species, in other words, must be read critically and in its entirety—its ontogeny and phylogeny as well as its structure.

The study of certain diagnostic features has resulted in the dividing up of species into geographical races or subspecies. This involves a tremendous amount of new considerations. For example, the individual characters of the ancestral specimen do not influence the formation of a new race; only that which is inheritable and non-pathological is of importance. Then, where two geographical races meet, there may be a strict line of demarcation with no attendant complications, or, on the other hand, there may be interbreeding producing an impure population of subspecies, not strictly distinguishable from, or identical with, either parent subspecies. This phenomenon is another which calls for further investigation.

Other geographical races which the systematist considers identical, though possessing no morphological differences, may have acquired physiological differences, which only experiment can detect. Another possible distinction may be found amongst gregarious mammals which show inheritable likenesses, probably impressed upon the herd by the dominant bull.

Systematics are not concerned solely with species and their variations but also genera and the higher categories, grouped according to relationship, that is, descent.

A brief survey, such as this, of the study of systematics is sufficient to illustrate its complicated nature and the possible ramifications into other branches of pure and applied biology; it demands the best scientific brains—those who not merely float but also dive.

World Reactions to Industrial Revolution

Various types of society, the world over, are trying to graft on to their ancient and traditionalist schemes of life the new scheme of mass-production developed as a dangerous experiment first in England about a hundred and fifty years ago. This reaction to the modern industrial revolution forms the substance of Prof. H. J. Fleure's presidential address to Section E (Geography) entitled "The Geographical Study of Society and World Problems". In vastly increased numbers the peoples of the world, some more, some less touched by the idea of mass-production, are jostling one another as never before, and various types of society have become, willy-nilly, standing dangers to others. In nearly all cases, societies have been in the past nearly self-contained groups, external commerce having been subordinate to internal exchange; and many of the modern groups that gather round a unity of language are attracted to this idea of self-sufficiency, often from fear of economic or political subjection. But diversity of past experience leads them along diverse lines of development, for human societies are primarily associations between men and the earth in particular areas; and must be studied objectively as such, as well as in relation to what they receive from without.

The groups of men who live by hunting, with collecting as an adjunct, were long ago the leaders of the world's life, and the lords of regions that can be determined by finds of their implements as apparently including North and East Africa and South-western Asia, with parts of Europe at times. They are now pressed into far corners in South-western Africa, Australia, and so on, or into the very unfavourable areas of the equatorial forests of the Old World. They have felt the pressure of agricultural peoples spreading from the Euphrates, the Fertile Crescent and Egypt, especially since cultivators and herdsmen have combined in social groups, with the latter as, usually, the ruling element, more markedly so after the horse had become the ally of the ruler.

The spread of the idea of cultivation and herding into inter-tropical Africa met many hindrances from climate, physiography, difficulty of adaptation of crops, fly-belts, phosphorus- and salt-deficiencies, that together kept back social development. Agriculture remained dependent on the hoe as a woman's implement, with the village poor and sometimes only temporary, and no development of cities; with medicine men rather than a more or less learned priesthood; message sticks and the like in place of a written script; and other contrasts all telling against the African, who must be thought of as struggling with special environmental difficulties. But agriculture even in Eurasia long remained traditionalist, though cities, priesthoods, writing, media of exchange, and so on enlarged men's vision; and, in conformity with tradition, this agriculture was usually on a communal basis.

So long as society remained traditionalist, there was implicit in its life the notion of the land as a trust handed along the generations, and that idea has struggled towards larger expression among the peoples who still look to agriculture as their main activity. Among such peoples, notably the French, the notion of stability is thus very strong, and the huge increase of industrial populations, on an essentially unstable foundation, in England, Germany, the United States and Japan, is naturally very disturbing. France has taken up into her strong system a certain measure of industrialist activity. China and India find the corresponding effort far more dangerous to their traditionalist schemes. Africa is waking up to the new contacts and ideas. In fact, the problems of the modern world can be expressed in terms of the multifarious reactions of peoples of diverse experience to the industrial revolution and its schemes of mass-production. But, underlying the diversities of reaction, there is everywhere a growing germ of the idea of economic independence that somehow has to be assimilated by a world policy.

Britain's Access to Overseas Markets

Prof. R. B. Forrester, in his presidential address to Section F (Economic Science and Statistics), directs attention to the increased anxiety over the position of the British export trade. The trade of the world has increased, but Britain's share has diminished. The reasons advanced to explain the slowing down of overseas sales of recent years have fallen into two main groups. First come those which emphasise the natural course of world industrial development, bringing with it the growth of local industries in many countries ; these new efforts, stimulated by the opportunities of the war years, have competed with the British staple exports such as textiles, iron and steel, engineering, and fuel output. Along with these difficulties, there has been the long series of casual misfortunes to which international trade has been subject in the years since 1920, such as restrictive customs tariff policies and the financial, exchange, and currency troubles.

The second group suggests that there is some special retarding cause operating against British export sales which is not present in the case of other countries exporting to world markets. This, it is argued, is to be found in the rigidity of the British income and price structure, which has not proved so adjustable as that of her trade rivals to the falling price levels of international trade.

It is, of course, possible to hold that all these causes are operating, and that Britain may be passing into a phase where the home market is of growing importance and overseas sales of diminishing extent. In the face of these difficulties, it is of some interest to inquire what the evidence is regarding Britain's access to external markets. The evidence of the economic missions which have examined selected markets in which British trade is losing its position suggests that, while price has been the main factor in explaining the decline, the selling methods require close examination and revision; adequate, no doubt, at a time of British predominance, they seem in need of alteration and adjustment to meet new forms of competition. It is also doubtful if the structure of the overseas distributive organisation is adequate to carry the increased tasks which must be undertaken to push British trade, and certain suggestions are made to meet this difficulty.

The position with regard to tariffs is considered only to see how far Britain is at any disadvantage compared with her trade competitors in gaining access to overseas markets. The central feature of her policy within recent times has been the unconditional interpretation of the ' most favoured nation ' clause ; this has in general guaranteed to her, entry of her goods exported at the lowest available rates of duty in the tariffs of other countries. It seems doubtful, however, how far this is now an adequate method of dealing with the world tariff situation, and to gain favourable access to external markets Britain may have to join tariff groups and employ group treaties to secure her position. One of her chief difficulties is that, like Germany, her exports are to so great an extent finished goods.

Britain is working her way to a new equilibrium between home and external markets and to a new proportion in the relative importance of her overseas markets ; she could certainly strengthen her position in overseas areas by improving her means of access in selling method and distributive organisation, as well as in directing her policy towards the creation of low tariff groups.

The Call to the Engineer

The engineer and scientific worker have shown the way to plenty. All the material necessities and comforts of life, with our known methods of manufacture and transportation, could be produced and distributed in sufficient quantity to make the inhabitants of the world ten times more wealthy than they are on the average to-day. That is the claim made by Prof. Miles Walker in his presidential address to Section G (Engineering), entitled " The Call to the Engineer to Manage the World ".

Civilisation has been extending for centuries, and the application of steam power to manufacture has been in operation for one hundred years, yet by far the greater portion of the inhabitants of Europe and America are very poorly supplied with the things that make life full, free, and enjoyable. If we go outside the modern States to the teeming millions of China and India, we find that only a little has been done to improve the lot of the peasant, who still lives by bodily toil, and receives no share of that fullness of life which we know to be possible when the machine lightens our labour and education opens the mind.

The great difference between what is possible and what has been achieved is in a great measure due to the incompetence of the rulers. The men who get into positions to control towns, provinces, and States the world over are very seldom men of real ability. They are talkers rather than doers. They have not undergone any test to show whether they can arrive at a logical conclusion from a given set of premises. Though there are brilliant exceptions, as a class they have neither the education nor the mentality for their job.

Contrasting the way in which things are managed in a great engineering undertaking with the way in which things are muddled in the world at large, we are led to believe that if the engineers (in which term, for brevity, may be included all scientific men) took a greater part in world management, they would make a greater success of it. In this world crisis there is a call to the engineer to manage the world.

One of the main things wrong with the world is that there is no proper plan to enable the people to make use of what science has made available. Men's efforts are mainly directed at buying and selling at a profit instead of being directed to the making of things they want, and distributing them in the least expensive way.

Two improvements that the application of scientific methods would effect would be the avoiding of trade slumps by the adjustment of prices and the avoiding of labour troubles by giving the arduous tasks to all the young men and women irrespective of rank.

At times when trade is supposed to be good, things are sold at three or four times the price paid to the people who make them, and as a consequence the people who make them cannot buy them, so there is a slump in the market. This is the main reason why there is so much unemployment and want in the United States, where food, raw materials, capital equipment, and everything for the production of wealth is in abundance. If prices were adjusted so as to cover the exact cost of manufacture and distribution, then the people concerned in the manufacture and distribution would receive enough money to buy them. They would make more and buy more, and wealth would increase. But the slightest illegitimate profit renders it impossible for the people who make the things to buy all that they have made. The demand necessarily becomes smaller and smaller, and wealth decreases.

Prof. Walker suggests that the Government should found an experimental self-supporting colony under the auspices of engineers, scientific workers, and economists. The object in view would be to ascertain how far it is possible, with our present knowledge and the best methods of manufacture and distribution, for a group of, say, a hundred thousand persons to maintain themselves and to increase continually their wealth when freed from the restraints and social errors of modern civilisation. Such an experiment might do more to enlighten the world as to the possibility of modern logical methods than an experiment carried out on a continent thousands of miles across, where unforeseen difficulties might easily defeat the best intentions. If we ask what differences there would be in the old world and those of the new colony from which so much is to be hoped, Prof. Walker, in partial answer, would draw two pictures. One is that of a feeble man of sixty years working all day in a sewer, because it is the only occupation he can find to earn his daily bread. Far worse, to him, than the unpleasantness of the task is the rankling injustice that he should be compelled to do this job for no more reward than a living wage, while others with easier tasks get greater rewards. The other picture is that of a young man of twenty-three years, who has chosen the task of sewerman in the spirit of those who went to the trenches in 1914. 'Sir Sewerman', aided by modern appliances, cheerfully puts in his three hours of unpleasant work, and for the rest of the day disports himself and extends his education.

So with all the work of mankind; it can be done cheerfully when justice seasons its incidence.

The Development of Archæology

The subject of Dr. D. Randall-MacIver's presidential address to Section H (Anthropology), is "The Place of Archæology as a Science and some Practical Problems in its Development". It is a very happy and propitious moment for the discussion of the place of archæology as a science and the practical policy which we ought to pursue in view of its startling and wide development. We need to devise methods of organisation, to think out means of collaboration, and to subdivide the field of our activities so that they may all be related in a conscious scheme.

Archæology is very closely related to anthropology; but, whereas anthropology is the wider of the two, the interest of archæology is solely in those works which can only be produced by man when he has become more or less *sapiens*. Without anthropology, however, archæology would be blind in one eye and very short-sighted in the other. What archæology discovers is the bare fact; it can never divine the essence of the fact, which gives it all its meaning and interest. For the whole meaning and rationale of man's life we are necessarily dependent on either anthropology or history.

Documentary evidence is very limited in its range, and although occasionally it usefully supplements our anthropological knowledge, its principal and indispensable function is that of affording a time-scale, which cannot be provided from any other sources. For the immeasurably remote periods of prehistory, geology provides a rough time-scale, which, however, is steadily being improved. About 3500 B.C. this clumsy instrument can be replaced by a much finer one derived from inscriptions and documentary evidence. This is the period of protohistory. But archæology does not end where history begins; and all through the classical periods of Greece and Rome, and all through the Middle Ages, history needs and receives the greatest assistance from archæology.

Turning to the organisation of archæology, this may be treated under three heads : the collection and recording of the material ; the housing, conservation, and exhibition of it in museums ; and the comparative study of all such material and the digesting and disseminating of the results in books.

As to the policy and necessities of the science in the collection of the material, there are one or two axioms which once were generally ignored. Of these the most important is that no person who is not qualified by special knowledge and study should ever be allowed to excavate at all, with the corollary that the excavator should be accredited by a properly constituted institution or committee. The looting of sites for the profit or amusement of a private individual will never be allowed again by any government. It ought to follow that digging for antiquities even by the owner of an estate should be forbidden. It is to be regretted that there is no scientific League of Nations, to which we might appeal for protection against powerful interests, whether individual or political.

It is the duty of the explorer to study and record whatever he finds. It is not quite so invariably part of his creed that he should publish, and that quickly and fully. Nothing—no display of plans, photographs, etc., however elaborate—can take the place of publication. A further principle is that a portion of every site should be reserved for future study. The wisdom of one generation, even our own, is unable to foresee all possible problems.

The archæologist's activities in museum work are to a great extent governed by considerations of space. It is said that the public does not want museums ; but granted certain exceptions, this is the fault of the museums, in which the visitor is left to drown in an uncharted sea.

In regard to the dissemination in books of the knowledge gained by excavation, the original scientific account is written for the professional and should give a precise account of every stage of the excavation ; but when the seed has been gathered and sown, it has to be watered. The semi-popular account may be undertaken by the original explorer or others. Lastly comes the general synthetic works of the writers who manufacture our fine fabrics out of the raw material ; for the most striking thing in the archæology of recent years is its sudden co-ordination. The ancient world now appears as a connected whole ; while time, thanks to the work of Sir Arthur Keith, Prof. Elliot Smith, and others, has shrunk no less than space. In this synthetic work, however, although the archæological imagination may find play, it must adhere to types of reason which may be regarded as conditionally valid.

Theories in Psychology

In the first part of her address to Section J (Psychology), entitled " Current Constructive Theories in Psychology ", Prof. Beatrice Edgell refers to the tercentenary of the birth of John Locke on Aug. 29, 1632. His " Essay Concerning Human Understanding " is primarily a theory of knowledge, but is full of psychological interest and rich in illustrations which would now figure as child, animal, or comparative psychology.

At the time at which Locke wrote, it was impossible for a writer to draw the distinction between a logical analysis of knowledge and a genetic account of knowledge in the individual and the race. Locke's ' simple ' idea stands sometimes for an ultimate constituent of knowledge, for a category of the understanding, and sometimes for primitive sensory experience ; consequently his ' plain historial method ' is misleading. Side by side with his doctrine that knowledge is the perception of the agreement or disagreement of ideas, Locke left a theory of the chance connexion of ideas by their association in time, a linkage which repetition can so strengthen that it comes to be regarded as ' natural ', that is, intrinsic. This theory was only put forward in the fourth edition of the essay, and was given as an explanation of error and prejudice. From it and from the doctrine of simple and complex ideas arose the association school of psychology, which culminated in James Mill's " Analysis of the Phenomena of the Human Mind ", 1829.

Implicit in the confusion of logical with psychological analysis and in the disparity of the two unreconciled principles of knowledge, intrinsic relation and temporal sequence or coincidence, lie the lines of cleavage which are clearly manifest in the diverse constructive theories put forward to-day. Behaviourism is association psychology in a physiological garb. Advance from simple reactions to complex conduct is ascribed to ' conditioning ', and conditioning turns on the sequence of stimuli. Psycho-analysis likewise relies on temporal association as a constructive principle, though the theory is grafted on to the root doctrine of the school, the unconscious with its emotions and instincts. The method, which gives this school its name, is not free from the confusion of psychological with logical analysis. *Gestalt* psychology strives to break away from the atomism characteristic of the association tradition. It detects the baleful influence of a doctrine of elements and compounds both in behaviourism and in the existential school of Titchener and his followers. In place of sensations as simple elements, the *Gestalt* psychologist recognises sensory patterns as simple wholes (*Gestalten*). In place of association, it preaches 'organisation'. The Neogenetic principles, put forward by Prof. Spearman as basic for any theory of psychology, assert, in agreement with Locke's definition of knowledge, that all knowing is a knowing of relations.

These divergences of theory are to be welcomed. Advance may be looked for not in the victory of one theory or method over all others, but in the discovery of the sphere appropriate for each. Every theory is recognising some aspect of truth. Adherence to a particular school ought not to blind a psychologist to an aspect of fact for which a rival theory offers a more adequate explanation.

In the second part of the address this thesis is illustrated by data from some experiments on memory recall.

Growth Processes in Trees

Many recent studies of growth in trees have added considerably to our knowledge of the various activities closely connected with arboreal development, and such considerations formed the basis of Prof. J. H. Priestley's presidential address to Section K (Botany) entitled "The Growing Tree".

One important recent discovery is that growth each season begins in the bud, whence it spreads downwards over the rest of the tree. These buds, of course, produce new shoots which grow in length, while the older branch systems thicken. Thus, growth in length and growth in thickness (radial growth) are intimately connected. Radial growth is dependent upon the activity of meristematic cambial cells, and this cambial activity only begins as the buds commence growth and then spreads downwards from the base of the buds. For this reason, when pruning, the stem should be cut just above a bud, for if a long piece of stem be left above a bud, since the cambium in it cannot resume activity, this stem withers to an unsightly projection.

The activities underlying growth and development are of importance in the comparison of the hardwood and softwood trees. The hardwood are dicotyledonous (Angiosperms), whereas the softwoods are chiefly coniferous (Gymnosperms). In softwoods, with the 'Christmas tree' habit of branching, radial growth begins below the buds and spreads downwards, but the lower and more shaded the branch, the slower radial growth activity spreads down it. Therefore cambial activity in the main trunk around the bases of the lower branches begins before it does on the branch bases themselves. Thus the old wood of the branch becomes gripped in the new wood of the trunk without actually becoming joined to it. Only later, as cambial activity on the branch begins, do branch and main axis join in forming a common sheet of wood. Therefore, in a thin softwood plank, the wood of the branch may lie loose in the wood of the trunk and knots may even fall out. In the hardwood, branching is by no means so regular, and cambial activity at a branch base begins about the same time as that of the main axis on the same level. Thus a common layer of new wood is formed at the beginning of renewed growth activity, with the result that knots in a plank of hardwood are fixed firmly in the matrix of main-stem wood.

Differences in the microscopic structure of softwoods and hardwoods are closely connected with differences in cambial activity. The cambium cells in the softwood are very long and thin with pointed ends. All new cells cut off from them are similar, very long cells, which expand, by absorbing water from the old wood, with great regularity, all cells in the same zone differentiating at the same time and in the same way. The result is the formation of a very regular woody tissue consisting only of narrow pointed tracheids. In the hardwoods, the cambium cells are much shorter and have relatively transverse end walls. The new tissues derived from this cambium have similar cross walls, and when these short cells expand with water, great strain is thrown upon these cross walls. A new 'strip' method of studying the development of these tissues has shown that as these cells expand, the cross walls collapse in some of the young cells. These cells immediately expand very widely; the walls then break down almost simultaneously in long files of cells in vertical continuity, and the result is the formation of vessels. This rapid expansion of cells in vertical files in the new tissues leads to a diversified structure in the wood finally formed. As the vessel segments expand, they compress cells around them, which are still in a plastic stage, and later form pointed fibres longer than the cambium cells from which they were originally derived. The differences in hardwood and softwood anatomy can thus be traced very largely to the original difference in length of the cambium initials from which these tissues are derived.

These characteristic growth processes necessarily have a direct bearing upon such problems as the movement of water in the wood and the translocation of food materials in the bast. Water is attracted by osmotic forces into the growing regions around the cambium and the buds. The old wood acts as a water reservoir. But the water is withdrawn more quickly than it is replaced, especially as transpiration from the expanding foliage becomes vigorous. The result is a state of tension, first in the outermost part of the old wood, then in the first formed elements of the new ring of wood. This tension is usually regarded to-day as sustained by liquid columns in the tracheal elements. But experiments are described in which liquid rushes up these tracheal elements when they are immersed and cut open, which suggests that many of the tracheal elements contain nothing but water vapour. In this way wood can be injected to great vertical distance in a very short time, if the liquids, like water, can pass the cross walls. This fact may not be without its practical application where trees have to be killed completely, as in clearing belts of country against the tsetse fly in tropical Africa.

Present-Day Teaching of Elementary Science

At the outset of his address to Section L (Educational Science) Mr. W. M. Heller discusses the functions of the Section. A generation ago it concerned itself with the place and character of school science, but of late years it has adapted itself to the study of the embryonic development of a science of education. He considers it more useful to record the convictions that remain from long contact with problems of teaching, inspection, and administration than to venture into the field of general educational philosophy. He sees great increase in the machinery of school science, but has grave doubts as to the design and efficiency of the machine. In elementary education we have not yet taken science seriously, and in future we must regard it as of the same fundamental importance as the three R's.

Curricula and methods are dominated still by men of unpractical upbringing and with little knowledge of or sympathy with the possibilities of scientific method and thought. Ignoring the change in the position of the mass-centre of human knowledge that has occurred during the past century, a blind faith persists in the grammarian tradition based upon a false and narrow conception of culture.

Without neglect of mental and æsthetic development, education must, in the broad sense, be directly and indirectly vocational. We must cater for the boy and the girl leaving school at fourteen, at fifteen, and at sixteen years of age, and must endeavour to place them in a position to face with success the employment and the problems that will confront them. No general school examination can direct usefully the various types of training necessary. The yoke of examination appears to hang more heavily than ever upon the shoulders of the teachers, who patiently accept the burden as part of a preordained scheme of things. In the years that need greatest concentration upon those aspects of training that no ordinary examination attempts to test, the evil spirit of external examination has obtained a stranglehold upon the efforts of both teacher and pupil. The problem of external examination is not unsolvable, but it must be faced with courage, and we must trust our teachers. Internal examination associated with sufficient and constructive inspection can provide every safeguard that the public can demand.

The term 'heuristic method' should be discarded, owing to the intemperate and destructive criticism that has centred around it; but tribute should be paid to the inspiration of Prof. H. E. Armstrong, who almost alone during the past fifty years has helped educationists to put purpose and method into their work. The term 'natural method' is adopted as less open to misinterpretation than 'heuristic method'. A broad course of general science is essential; the artificial barriers between subjects set up for the convenience of external examinations must be broken down, the teacher must be free, if necessary, to touch half a dozen sciences in one and the same lesson. The lack of progress in general science is due to the narrow specialisation of students in the university, and this is reflected in the schools by the absence of useful and vocational purpose. The training of the future science teacher needs radical change, and more deliberate purpose; he should be able to teach efficiently any section of a general science course; he must be a far more handy-man in every sense of the word than the present university output provides.

The historical and philosophical treatment of education does not produce practical and resourceful teachers, and theoretical training would be more effective if undertaken after some years of thoughtful experience. The art of teaching must develop along inductive lines; we must concentrate upon a product equipped to gain knowledge from experience and conscious that success in his art can be achieved only by his own investigation.

Less advance has been made in domestic science than in other practical studies. Domestic duties call for more intelligence, knowledge, and initiative than do the vocations followed by boys. The academic courses that boys usually follow make little appeal to girls. There is need for better correlation between the teaching given in the laboratory and the kitchen, and we shall not get the best out of either of these aspects of domestic science until both are taught by one and the same person. Neither the university nor the domestic training school are turning out the right type of teacher.

The address of the previous occupant of the Section's chair at York—Sir Michael Sadler—recalled the traditional ruts in which education moved, the concentration upon book-learning, the neglect of handwork, and our wastefulness of the more ordinary kinds of intellectual material, which were regarded by Sir Michael as the besetting weakness of the time. He deplored the worship of examinations as destructive of teaching and learning alike; but he did not foresee the extent to which machine-made examination would divert from its proper purpose the major part of our educational effort.

Sheep Farming in Great Britain

Sheep farming is usually associated with ranching systems in zones beyond the areas in which cultivation and dairying are economically possible. Yet Great Britain occupies about the eighth place in a list of the countries of the world arranged according to total number of sheep, and it is only surpassed by New Zealand as regards density of sheep population. The great importance of this branch of British agriculture forms the basis of Prof. R. G. White's presidential address to Section M (Agriculture), entitled "Sheep Farming, a Distinctive Feature of British Farming". Compared with other European countries, we have many times the number of sheep per unit area of agricultural land.

This special importance of sheep is no new feature of British agriculture, and it has had profound effects on our national life as well as on our agricultural organisation. During the Middle Ages, continental manufacturers looked to Great Britain for their supply of wool, just as the Yorkshire manufacturer now goes to Australia. Until the latter half of the eighteenth century, wool production was much the most important function of the national sheep flock. Meat production became more important during the eighteenth century, when the demands of the increasing urban population and the introduction of roots and clover altered the whole basis of British agriculture. During the last thirty or forty years there have been great changes, largely resulting from the development of the fat lamb industry, but also in great measure due to the low prices of grain.

These changes have resulted in great modification of the composition and distribution of our flocks. On light land in the south and east of England, 'arable sheep' managed on a very intensive system play an important part in maintaining the fertility of the soil for corn growing. So much land has been laid down to grass, or is now cultivated on a different system, that the total sheep stock in these areas has been reduced by more than fifty per cent. Although there have been large increases in other districts, for example, North Wales and the east of Scotland, they by no means provide full compensation for the loss. To a very large extent, our sheep stock consists now of hill breeds and their crosses, which are kept on an extensive system involving little outlay on labour, feeding stuffs, or permanent equipment. Their substitution for arable farming has brought about a general decline in the life of the countryside.

On the other hand, at the present time sheep provide the only possible way of utilising the large areas of hill land economically, and an outlet for the draft ewes and store lambs is essential. Moreover, grass sheep, managed in such a way as to meet present demands, fit in well with grass production, for which the climate makes the greater part of Great Britain best suited.

Possible developments include a consideration of the practicability of securing a greater return per unit of the flock; possible changes in management and functions; and the highly controversial question of the need for maintaining our great number of different breeds. The diseases of sheep are of great importance to flock management, and in this connexion there is an urgent need for more research.

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application, and no injury to any of the plants was observed. Although no special apparatus is essential, the following method for distribution is suggested. A water suction pump (ejector) is attached to the garden tap, and hose piping leads from the suction opening into the barrel containing ammonium sulphide solution. The distributing hose is connected to the other end of the filter pump. On turning on the tap, the solution is drawn off from the barrel, mixed with water from the tap, and forced through the distributing hose. Calculation and trial are of course needed to determine the strength of ammonium sulphide solution in the barrel in order to yield 1 part in 30 in the distributing hose. Mr. Van Riper would welcome the reports of other experience in the use of this method for slug eradication.

Narcissus Pests

Bulletin No. 51 of the Ministry of Agriculture and Fisheries (May 1932), entitled "Narcissus Pests", by Mr. W. E. H. Hodson, has recently come to hand. The object of this publication is to provide growers with reliable and up-to-date information enabling them to control the more common and destructive of the enemies of the narcissus. The Bulletin deals with the species of flies of which the larvæ are persistent enemies of the bulbs, while eelworms, mites, and other pests are also fully discussed. The most satisfactory treatment for all such pests is the submersion of the bulbs in water maintained at a temperature of 110° F. for three hours. If such treatment were not available it is highly probable that the bulb eelworm would by now have rendered commercial growing almost impracticable. The Bulletin is obtainable, price 1*s.* net, from H.M. Stationery Office or through any bookseller.

Penguins' Eggs

The appearance of the eggs of penguins in some of the large London stores, where they were sold as epicurean novelties at ten shillings a dozen, led the Royal Society for the Protection of Birds to make inquiries regarding the source and supply (*Bird Notes and News*, vol. 15, No. 2, p. 39, 1932). The eggs were those of the Cape or black-footed penguin (*Spheniscus demersus*), and were obtained in one of the extensive penguin rookeries in the Cape Province of the Union of South Africa. The eggs were collected for sale under Government regulation, and the Trade Commissioner for South Africa informed the Society that during the months of April and May of the present year some 2000 dozen of the eggs were exported to Great Britain. We hope that the Government department which regulates the taking of the eggs will see to it that the strength of the penguin colony is not too seriously reduced, remembering the fate of the gare-fowl when commerce invaded its innumerable hordes ; and we trust that the exceptional opportunity will be taken of associating the statistics of eggs taken with the total strength of the colony year by year, for the study of the effect upon the population of the colony as a whole.

Monument to Laplace

The issue of *Revue Scientifique* for Aug. 13 briefly records the inauguration on July 3 of a monument to the great French mathematician, Laplace, at his birthplace, Beaumont-en-Auge (Calvados). The monument, which is the work of M. R. Delandre, has been erected by international subscription, among the principal contributors to which were Messrs. J. H. Fry and J. Flanagan, of the United States, and the two Carnegie Foundations for Science and Peace. The unveiling took place in the presence of Maréchal Franchet d'Esperey, of the Société de Géographie of Paris, and distinguished representatives of the Academy of Sciences, the Paris Observatory, and the École Polytechnique. As recorded in Nature for April 2, 1927, p. 493, at his death in March 1827 Laplace was buried in the Père Lachaise cemetery in Paris, but sixty-one years later, in 1888, his remains were exhumed and reinterred in the grounds of the family estate at the little hamlet of Saint Julien de Mailloc, situated between Lisieux and Orbec (Calvados). At the time of the reinterment, the monument which had marked the resting-place of Laplace in Paris was presented to the commune of Beaumont-en-Auge, and was re-erected in the cemetery there.

Discovery of the Deviation of the Compass

In the July issue of *Science Progress*, Mr. N. H. de V. Heathcote brings together the data at present available for fixing the date of the discovery of the deviation of the compass from true north. The figure in the instructions of the Nautical Chart of Bianco of 1436 which has been taken as evidence that a correction for a deviation of 18° west of true north was allowed for, the author concludes has nothing to do with deviation. The first definite record of deviation he considers to be that made by Columbus in September 1492, during his first voyage across the Atlantic. In his record of his return in 1496 from his voyage to India, Columbus mentions Flemish compasses which read 11¼° west of north when the Genoese compasses read north. Mr. Heathcote points out that pocket sundials were in use in Germany about the middle of the fifteenth century which were set in the meridian by a compass ; in the latter an allowance for a deviation of 6° east of true north was made, while in Etzlaub's road map of Germany of 1492 instructions are given for orienting it correctly by compass, an allowance for deviation of 11¼° being made. He concludes that pocket sundials with an arrow set 11¼° east of north were familiar objects in Germany before the time of Columbus.

Bibliography of Line Spectra

No better comment could be made on the present importance of line spectroscopy than the publication by the American Physical Society in *Reviews of Modern Physics* (April) of a bibliography of the papers which have appeared between 1920 and 1931. This has been compiled by R. C. Gibbs, and is prefaced by a short elementary account of the interpretation of spectra. The bibliography is divided into three sections. The first, which contains the majority of the references, is a list of those papers which contained new data or discussions ; these are divided according to elements, stage of ionisation, year of publication, and alphabetical order of authors, and in general, when one paper has dealt with several elements, it has been listed under each to avoid cross-references. The two other sections are much shorter, and deal with more general publications, articles mainly concerned with the mathematical machinery of quantum mechanics not being included. The lists occupy some 150 pages of small print, and although essentially uncritical, should be of the utmost value to all workers in spectroscopy.

Progress in Modern Physics

In his introduction to a set of pamphlets on recent developments in physics (" Exposés de physique théorétique ") published by Hermann et Cie, of Paris (6 francs each), Prof. L. de Broglie raises once more the question of how contact can be maintained between workers at different branches of physics. It is now quite impossible for any one person both to read critically all new papers, in any but a most limited field, and to advance the subject himself. Realisation of this is, of course, not new, and has inspired, amongst other publications, the American Physical Society's *Reviews of Modern Physics*. The present series seems likely, however, to fulfil its purpose better than anything that has gone before. Although definitely for advanced workers, the articles are anything but abstracts, being well written and critical, and containing adequate detail without providing what is really irrelevant to anyone not a specialist in the particular subject dealt with. They also deal with relatively new or very recent work. Of the two at present under notice, Prof. de Broglie's is based on Landau and Peierl's treatment of the uncertainty principle (*Z. Phys.*, vol. 69, p. 56), and is purely theoretical. The other, by Irène Curie and F. Joliot, is an account of the neutron experiments, particularly those done by the workers in Paris ; it contains an interesting set of reproductions of Wilson cloud trails, which supplement those recently published by Feather and Dee in the *Proceedings of the Royal Society*. Each article occupies a little more than twenty pages, and although attractively presented, is certainly cheap.

Cadastral Survey and Land Records

During the Conference of Empire Surveyors held in London last year, there was exhibited at the Science Museum a number of cadastral survey, land registry, and land revenue records. The Royal Geographical Society, at the instance of the Secretary of State for the Colonies, has arranged to house these exhibits, and hopes to make them the nucleus of a permanent reference collection in London. It is expected that the collection will include land laws, regulations, and technical instructions from all parts of the world, and will be representative of progressive advances in cadastral survey and land records in each country. Sir Ernest Dowson and Mr. V. L. O. Sheppard have jointly undertaken the collection, study, and maintenance of the documents.

Oil Fuel for Horticultural Purposes

The seventeenth annual report (1931) of the Cheshunt Experimental and Research Station contains a short account of a test with an automatic heating installation using oil fuel. A thermostat in the tomato greenhouse controls the action of a crude oil burner which gives heat to a special hot-water heating boiler. The account is quite short and the experiment incomplete, but the results show that an enhanced yield can be expected from the increased night temperature. Moreover, the fungus disease known as tomato leaf mould was kept in check by the higher temperature.

Announcements

The thirty-sixth autumn fungus foray and annual general meeting of the British Mycological Society will be held at Haslemere, Surrey, on Sept. 19–24. Miss G. Lister will deliver the presidential address, entitled " Field Notes on Mycetozoa ", on Sept. 21. Several interesting local excursions have been arranged in connexion with the meeting

The Society of Biological Chemists (India) has made itself responsible for an interesting pamphlet, " Biochemical and Allied Research in India in 1931 ", in which in about forty pages Indian biochemical research in different fields is summarised in a series of brief reviews by some six contributors. The papers cited, of which the majority appear to have been published in 1930 and 1931, number no less than 181. These brief summaries are grouped under various sub-headings—for example, enzymes and fermentation, agricultural chemistry, chemistry of nutrition, etc.—and seem to be very concisely done, so that this little pamphlet should be useful to many biochemical workers outside India.

The Society of Petroleum Geophysicists (America) has issued volume 1 of its *Transactions*, comprising a series of important papers presented by the Society at the annual convention of the American Association of Petroleum Geologists at San Antonio in March 1931. Most, if not all, of these papers have appeared in the *Bulletin* of the Association, but now they are available in a convenient, compact form. The titles are : " Application of Seismography to Geological Problems ", by E. McDermott ; " Belle Isle Torsion-Balance Survey ", by D. C. Barton ; " Some Results of Magnetometer Surveys in California ", by E. D. Lynton ; " Magnetic Disturbance caused by Buried Casing ", by W. M. Barret ; " Brunton Compass Attachment for Measurement of Horizontal Magnetic Intensity ", by J. H. Wilson ; " Utilization of Existing Wells in Seismographic Work ", by B. McCollum and W. W. La Rue ; and an " Analysis of some Torsion-Balance Results in California ", by R. H. Miller. The editor is F. H. Lahee, and an introduction has been written by G. H. Westby. The volume can be obtained in England from Messrs. Thomas Murby and Co.

Applications are invited for the following appointments, on or before the dates mentioned :—A male junior assistant (chemistry) at the Experimental Station, Porton, near Salisbury (War Department)—The Chief Superintendent, Chemical Defence Research Department, 14 Grosvenor Gardens, S.W.1 (Sept. 12). A chief workshop instructor in the Mechanical Engineering Department at the Northampton Polytechnic Institute, St. John Street, E.C.1—The Principal (Sept. 15).

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.*]

Photography of Penetrating Corpuscular Radiation

SINCE Skobelzyn [1] discovered the tracks of particles of high energy on photographs taken with a Wilson cloud chamber, this method has been used by him and others in a number of investigations [2] of the nature of penetrating radiation. Such work is laborious, since these tracks occur in only a small fraction of the total number of expansions made. We have found it possible to obtain good photographs of these high energy particles by arranging that the simultaneous discharge of two Geiger-Müller counters due to the passage of one of these particles shall operate the expansion itself. On more than 75 per cent of the photographs so obtained (the fraction depending on the ratio of the number of 'true' to 'accidental' coincidences) are found the tracks of particles of high energy.

Mott Smith and Locher [3] had previously found a correlation between the occurrence of these tracks and the discharge of a tube counter, and recently Johnson, Fleicher, and Street [4] have used the coincidence of the discharges of two counters to operate the flash which illuminates a continuously working cloud chamber.

The chamber we used has a diameter of 13 cm. and has its plane vertical, with one tube counter above and one below, so that any ray which passes straight through both counters will also pass through the illuminated part of the chamber. A magnetic field is applied at right angles to the plane of the chamber. When the cloud chamber has been made ready for use, the arrival of a coincidence is awaited. After an average wait of about two minutes, a coincidence occurs and a relay mechanism starts the expansion.

The tracks have a definite breadth due to the diffusion of the ions during the time between the passage of the ray and the attainment of supersaturation. The chamber was designed so that this time

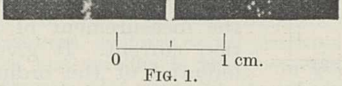

FIG. 1.

should be very small; it was in fact 0·01 sec. The observed breadth of the tracks in oxygen at 1·5 atmospheres pressure was 0·8 mm., and in hydrogen 1·8 mm. (Fig. 1). These breadths are in close agreement with the values calculated from the theoretical relation $\overline{x^2} = 2\,D\,T$, giving the mean square displacement in terms of the diffusion coefficient and the time. In spite of this breadth, the tracks in oxygen are admirably suited for accurate measurement.

The method is very economical in time in comparison with the usual method. Though the track of a fast particle may be obtained every tenth random expansion, only a few of such tracks are of use if an accurate determination of the energy of the particles is to be made. For this purpose it is desirable that a track shall lie in the plane of the chamber, for this ensures that it will be long, in perfect focus, and at right angles to the field. The fraction of random expansions which show such tracks is very small. Again, it is easier to adjust a chamber to take a few good photographs than it is to maintain the adjustment while taking many thousand.

The method has one disadvantage. The technical problem of obtaining a very large magnetic field over the whole chamber, such as has been obtained by

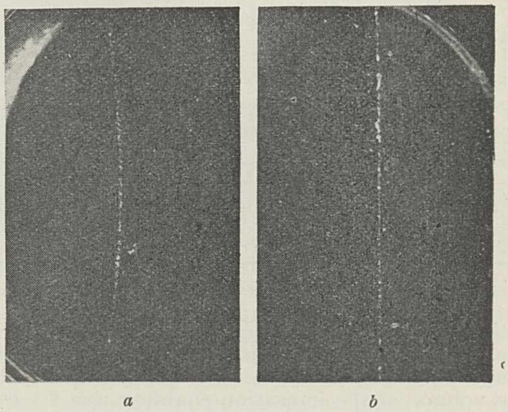

FIG. 2.—Tracks of high-speed particles. (*a*): $H\rho$ about 68,000 gauss cm., corresponding electron energy 20×10^6 volts; (*b*): $H\rho$ probably about 2×10^6 gauss cm., corresponding electron energy 600×10^6 volts.

Millikan and Anderson, is difficult, since the field must be maintained for periods of some minutes, while, when making expansions at random, it is only needed for a fraction of a second.

Among one hundred stereoscopic pairs of photographs, 59 showed the track of a single high speed particle passing through both counters (Fig. 2, *a* and *b*); 17 showed either multiple tracks of varying degrees of complexity, such as have been found by other workers, or else a single track passing through one but not both counters; 24 showed no tracks. Only about ten per cent of the tracks were markedly bent in a field of about 2000 gauss. Assuming them to be electrons, their energies lay between 2 and 20 million volts. To estimate the energy of the particles producing the main group of nearly straight tracks, the angular resolving power of the apparatus was determined by measurement of tracks obtained with no magnetic field. It was found in this way that a *mean* deviation of $\frac{1}{3}°$ could be considered as significant. Since the tracks obtained with the magnetic field of 2000 gauss showed no such deviation, it was concluded that the *mean* $H\rho$ of these particles must have been greater than 2×10^6 gauss cm. If the particles were electrons, their *mean* energy must have been greater than 600 million volts, or if protons, greater than 200 million volts.

P. M. S. BLACKETT.
G. OCCHIALINI.
The Cavendish Laboratory,
Cambridge,
Aug. 21.

[1] Skobelzyn, *Z. Phys.*, **54**, 686; 1929.
[2] Skobelzyn, *Comptes rendus*, **194**, 118; 1932. Auger and Skobelzyn, *Comptes rendus*, **189**, 55; 1929. Millikan and Anderson, *Phys. Rev.*, **40**, 325; 1932.
[3] Mott Smith and Locher, *Phys. Rev.*, **38**, 1399; 1931: **39**, 883; 1932.
[4] Johnson, Fleicher, and Street, *Phys. Rev.*, **40**, 1048; 1932.

Intensity of Cosmic Radiation in the High Atmosphere

On Aug. 12, I succeeded in measuring the intensity of cosmic radiation in the high atmosphere, at air pressures down to 22 mm. of mercury, by means of two rubber balloons and a self-registering electrometer. The electrometer was working on the same principle

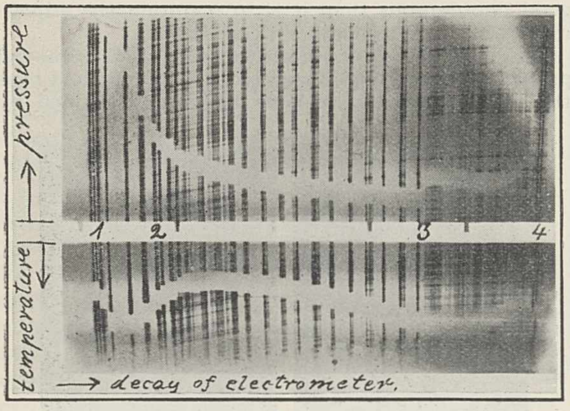

FIG. 1.

as that used for the investigations in Lake Constance.[1] The position of an electrometer wire is photographed every four minutes on a fixed photographic plate. The volume of the ionisation chamber was 2·1 litres, the thickness of its walls was 0·5 mm. The air pressure outside and temperature within the apparatus were measured simultaneously with the electric tension by limiting the length of the wire pictures by an aneroid on one side and by a bimetallic lamella on the other. The apparatus was protected against the low air temperature in the stratosphere by a case of 'Cellophane', which catches the sun's rays like a 'forcing-house'. Therefore the temperature inside the apparatus only varied between + 15° and + 37 C°.

Fig. 1 is a reproduction of the results obtained on the photographic plate. At point 1 the apparatus begins to operate, between points 2 and 3 the tension is measured every 4 minutes, after 3 one of the balloons explodes, point 4 shows the landing. Between 2 and 3 the air pressure (upper limit of the wire photographs) varies from 243 to 22 mm. of mercury.

Fig. 2 shows the results from this plate together with the end of the corresponding curve of Kolhörster and the value obtained by A. Piccard in 1931.[2] The intensity I of the cosmic radiation (I=pairs of ions per cm.^{3} sec.) is given as a function of the decreasing air pressure (in mm. of mercury). The following results may be derived from this curve:

(1) Below 150 mm. mercury (that is, above a height of about 12 km.) the intensity of cosmic radiation increases less rapidly as one approaches the end of the atmosphere.

(2) At lower pressures the intensity approaches rapidly its highest value. Therefore it is possible to extrapolate the intensity of radiation at its entrance in the atmosphere. One gets a preliminary value of 275 I., provided that the intensity does not pass through a maximum value and decrease again at greater heights. This might be the case in consequence of result (3).

(3) The cosmic radiation saturates itself with secondary radiation after having entered the atmosphere. If it remained a mere primary radiation, its intensity would decrease much more rapidly at great heights, and the curve of Fig. 2 would have no point of inflection.

(4) There seems to be no γ-radiation of the common radioactive bodies in outer space. Otherwise it would give rise to a new increase of intensity in the highest parts of the curve, as about 20 per cent of the common γ-rays would pass through a layer of air corresponding to a pressure of 22 mm. of mercury.

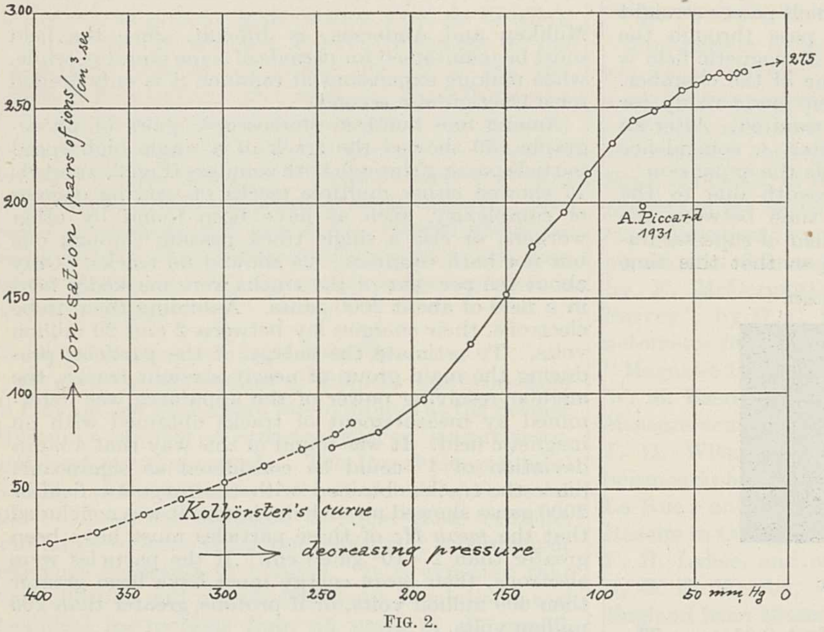

FIG. 2.

Supposing air temperature is constant and equal to 0° C., a height of 28 km. corresponds to a pressure of 22 mm. of mercury.

A more detailed report of the investigation will be published shortly in *Die Naturwissenschaften*.

E. REGENER.

Physical Institute of the Technical High School, Stuttgart, Aug. 20.

[1] *Z. Phys.*, **74**, 433; 1932.
[2] *Naturwissenschaften*, Aug. 5, 1932.

The α-Rays of Ionium

THE differential method of Lord Rutherford for counting α-particles may of course be used, and with great advantage, for the measurement of the ionisation current. It gives the differential of the ordinary Bragg curve, the variation of the ionisation from element to element of distance, rather than the total ionisation for the element.

I have constructed an apparatus for this purpose capable of considerable accuracy, and the results so far obtained in calibrating it with the α-rays of polonium and ionium have features difficult to interpret. It has three ionisation chambers, 1·85 mm. deep, separated by aluminium leaf equivalent in stopping power to about 1 mm. of air, the one nearest the source being a guard chamber, and the current through the middle chamber being opposed by that through the posterior chamber. The depth of the latter can be varied by screw adjustment, and, in use, it is set so that the currents balance, with polonium as the source of α-rays, at the beginning of the effective range. The pitch of the screw was $\frac{1}{25}$ in. (1·016 mm.).

The first curves obtained with polonium and ionium are shown in Fig. 1, with the experimental points indicated by circles. Rosenblum has shown by magnetic analysis that the α-rays of polonium are

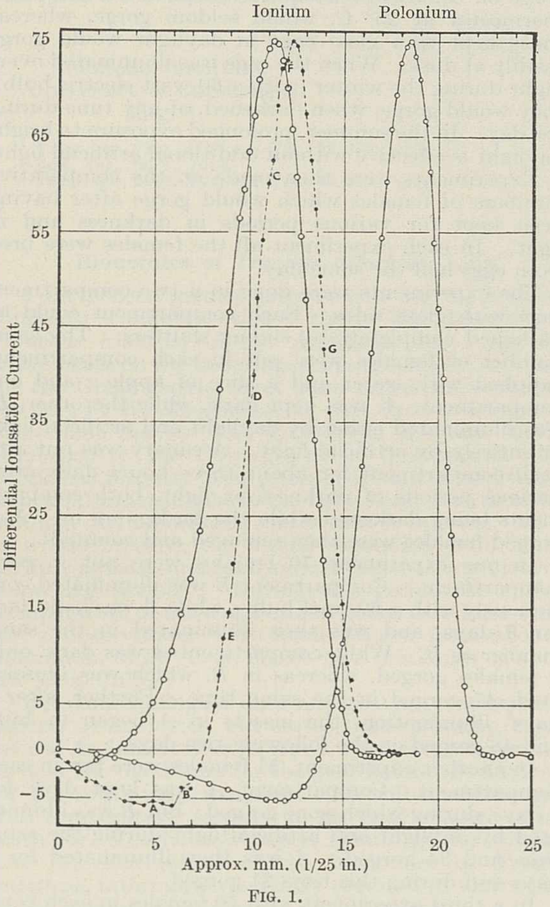

FIG. 1.

homogeneous, and the curve may be taken as that for homogeneous α-particles. It will be seen that on bringing up the preparation from a distance, the current, after rising to a maximum and falling to zero, changes sign and passes through a minimum before reaching zero again at the beginning of the effective range, for which the chambers are balanced. At greater distances, so long as all the rays traverse both chambers, the current in the posterior one predominates, through the increase in ionising power towards the end of the range.

The ionium curve corresponds very closely with that for polonium, so far as the right limb is concerned, but departs markedly for the left limb. The slope is more gradual, and no actual minimum is reached. Also there is a clear inflection at about 2 mm. from the maximum, as though rays of shorter range were present. The ionium employed was an ionium-thorium oxide, prepared by Miss Hitchins and myself from St. Joachimsthal pitchblende residues, and shown, from the rate of growth of radium, to contain ionium and thorium in the ratio 53 : 47.[1] It was finely powdered, and 5 mgm. spread as evenly as possible on a disc 5 cm. in diameter. For a uniform layer, the equivalent stopping power would have been about 1 mm. of air.

To determine the effect due to absorption in the film, another, containing only about 1 mgm. of ionium oxide, was made by evaporating and igniting a solution of the nitrate. Owing to the reduced activity, the curves could not be taken with so great accuracy as before, especially in the neighbourhood of the zero. But all the curves obtained agreed in their main features and differed distinctly from the polonium curve. The mean of the results for the three most complete curves is shown by a dotted line in Fig. 1, the black dots being the experimental points for the most extended single set of measurements.

The minimum is now more pronounced than for the polonium curve and shows definite irregularities at points marked *A* and *B*. The inflection on the left slope in the first curve is marked *C*, and three others are indicated at *D*, *E*, and *F* on this branch, with another at *G* on the right branch. Though small, they appear to be real.

The curves in the figure are not reduced to standard temperature and pressure, but the first two refer to nearly standard conditions. The difference in range between the two ionium preparations is due, one-third to the dotted curve being taken with a lower barometer and higher temperature, and two-thirds to the effect of absorption. Conformably with this, while the corrected ranges found from the two full curves agree with the values usually accepted, 3·87 cm. and 3·195 cm. respectively, the more accurate value for ionium, obtained from the dotted curve, 3·22 cm., is about 0·25 mm. greater than the accepted value.

At first sight it would appear natural to ascribe the irregularities found for the ionium curve to heterogenity of the rays, as found by Rosenblum and others for thorium C, radioactinium and several other 'α-rayers', and to look for a γ-radiation from ionium, which, on Gamow's theory, should be associated with the short range α-rays. I do not think ionium is known to give a γ-radiation, but all my preparations show a detectable penetrating radiation, more penetrating than β-rays, which, though small, is in excess of that due to contained thorium.

Unfortunately, however, for this explanation, the ionium curve obtained for the weaker preparation is distinctly less broad than that for polonium. A careful comparison of the reduced curves showed the latter to be from 0·3 mm. to 0·4 mm. the broader over the lower positive part of the curve. This, owing to straggling, is what is to be expected for the longer range rays of polonium, *if those of ionium are homogeneous*. If the latter were composed of rays of different ranges, this method must reveal it by a corresponding broadening of the curve. The cause of the irregularities thus remains for the present unknown, but more experience with the method may reveal it.

FREDERICK SODDY.
University Museum,
Oxford.

[1] *Phil. Mag.*, **47**, 1148; 1924.

The Glow in Photoelectric Cells

MAKERS of photoelectric cells usually state the limits of e.m.f. which can be used, and beyond which a glow discharge sets in. Although I have not met with any explicit statement, it seems to be implied that short of this e.m.f. no glow is visible.

Recently, when using a 'Madza' thin film cæsium cell (made by the British Thomson-Houston Co., Ltd.)

to indicate the intensity of an infra-red beam, I noticed that the cell was visibly luminous. The luminosity ceased when the infra-red beam was intercepted or the electric circuit broken, and is, without doubt, due to excitation of the residual gas atoms (argon) by electronic collisions. There is, of course, nothing radically new in this, since excitation potentials have been exhaustively studied. The novelty, if any, is that here the source of electrons is a photoelectric surface, instead of the hot wire usually employed.

The older types of photoelectric cells were sensitive only to visible light. This would tend to mask the comparatively feeble glow, and thus prevent its being noticed. In my experiments, the beam was infra-red light, isolated by a filter of red glass combined with a thick block of cobalt blue. The source was a small incandescent lamp focused on the cell, and the residual red passed by the filter was almost imperceptible, making it easy to observe the glow.

Some tests were made to observe the minimum e.m.f. for a perceptible effect. The observer's eyes were well rested in the dark. It was found that when the full working voltage of 70 volts or so was applied, glow filled the whole space between the wire anode and the hemi-cylindrical cathode surface. As the voltage was diminished the luminosity shrank, as might be expected, to the neighbourhood of the central wire, since it is here that most of the voltage is dropped.

Careful experiments showed that luminosity could be seen at 15·85 volts but not at 15·75 volts. These observations were made by my assistant, Mr. R. Thompson, whose eyes are younger than mine. I was not myself able to see light at quite so low a voltage. We may take the intermediate value, 15·8 volts, as the minimum for visible luminosity under the conditions. This is very close to the lower of the two ionisation potentials of argon, which, from the optical evidence, should be 15·72 volts. Luminosity should be observable below the ionisation potential, and, in fact, Horton and Davies [1] were able to observe it at 15·1 volts, using the ordinary hot wire source of electrons.

It has seemed worth while to describe this method of observing with the photoelectric cell, because it is easy and instructive, and requires only ready-made commercial apparatus. If a fairly sensitive galvanometer is included in the circuit, the current–e.m.f. relation can be examined at the same time, and it can be seen that luminosity sets in at about the point where ionisation by collision appears.

The method could perhaps be developed for accurate determination of excitation potentials of the various spectrum lines.

RAYLEIGH.

Aug. 18.

[1] *Proc. Roy. Soc.*, A, **102**, 131 ; 1922.

Influence of Light on the Gorging of *Culex pipiens* L.

IN England the blood-feeding habits of *Culex pipiens* have been subject to doubt. Thus, MacGregor [1] states that " Attention must be drawn to the discrepancies which seem to exist between the habits of the representatives of this species in Britain, the U.S.A., France and elsewhere. For instance, great difficulty is ordinarily experienced in Britain in getting *C.* (*C.*) *pipiens* to ' bite ' naturally ; so much is this the case that it is even now not generally recognised that the species is a blood feeder in this country." Woodcock, on the other hand, says that " *Culex pipiens* is essentially the British mosquito which likes Avian blood ".[2] Hitherto the difficulty of inducing *C. pipiens* to gorge under experimental conditions has been a source of difficulty to workers, and MacGregor [3] says that in his work on avian malaria " an unforeseen difficulty arose in that only a very small proportion of the mosquitoes (*Anopheles maculipennis*, *Culex pipiens* and *Aëdes argenteus*) could be induced to feed on birds ".

While breeding *C. pipiens* for work on mosquito infection in avian malaria on behalf of the Medical Research Council, we noticed that light appeared to be an important factor in inducing *C. pipiens* to gorge on canaries. Mosquitoes kept in the dark in a thermostat at 25° C. would seldom gorge, whereas those kept in a glass cage in daylight would gorge readily at dusk. When the cage was illuminated overnight during the winter (with a 60-watt electric bulb), they would gorge, when darkened, at any time during the day. In the summer, prolonged exposure to bright daylight is effective without additional artificial light.

Experiments were then made on the comparative numbers of females which would gorge after having been kept for various periods in darkness and in light. In each experiment all the females were bred from eggs laid the same day.

The experiments were done in a two-compartment cage with glass sides. Each compartment could be darkened completely by sliding shutters. The same number of females were put in each compartment, supplied with water and a slice of apple ; and one compartment, *A*, was kept dark, while the other, *B*, was illuminated either by daylight and artificial light or entirely by artificial light. A canary was put into each compartment for about three hours daily after various periods of darkness or light, both compartments being darkened while the birds were in. Any gorged females were then removed and counted.

In one experiment 70 females were put in each compartment. Compartment *B* was illuminated continuously with a 60-watt bulb ; while *A* was kept dark for 6 days, and was then illuminated in the same manner as *B*. While compartment *A* was dark, only 2 females gorged, whereas in *B*, which was illuminated, 47 gorged in the same time. Further, after 3 days' illumination, the insects in *A* began to bite, and 48 gorged on the following two days.

In another experiment, 51 females were put in each compartment. Compartment *A* was kept dark for 5 days, during which none gorged ; but *B* was illuminated by daylight and artificial light during the same time and 34 gorged. *A* was then illuminated for 8 days and during this time 21 gorged.

In a third experiment with 70 females in each compartment, *A* was kept dark for 7 days, during which 2 gorged ; and during the same time 32 gorged in *B*, which was illuminated with daylight and artificial light. *A* was then illuminated for 10 days, and during this time 33 gorged.

The temperature was recorded daily in each compartment, and although it fluctuated about 5° C. with the room temperature, it never varied more than 1° C. between the illuminated and the dark compartments.

We have also observed that the females which gorge after being kept in the dark, if dissected immediately after biting, show more developed ovaries and less fat-body than the females kept in the dark.

Further work on these lines is in progress and will be published in detail elsewhere, but the results already obtained show definitely that, under experimental conditions in England, *Culex pipiens* will gorge readily when placed in the dark after prolonged exposure to light, but if kept continuously in the dark will only rarely gorge. In our experiments, of those kept in the dark, only about 3 per cent gorged, while after exposure to light 66-90 per cent gorged. To our knowledge, this phenomenon has not previously been observed.

By utilising this method of obtaining large numbers of gorged females, and feeding the larvæ on boiled bakers' yeast, we can breed *Culex pipiens* very successfully under laboratory conditions. About 20 per cent of the egg rafts are fertile, and the mortality from eggs to imagines is not more than 10 per cent. Starting with hibernating females, we have now raised the third generation of imagines, each generation having comprised thousands of individuals.

P. TATE.
M. VINCENT.

Molteno Institute,
University of Cambridge,
Aug. 1.

[1] *Trans. Soc. Trop. Med. and Hyg.*, **24**, 470; 1930–31.
[2] *Zool. Anz.*, **18**, 8; 1914.
[3] *Trans. Soc. Trop. Med. and Hyg.*, **23**, 203; 1929.

Bionomics of *Trochus niloticus*, Linn.

I HAVE been greatly interested in Dr. C. Amirthalingam's communication [1] about the breeding of *Trochus niloticus* in the Andaman Sea. My own statements on the breeding of this species in the waters of the Great Barrier Reef were based on work done by Mr. F. W. Moorhouse, at that time a member of the Great Barrier Reef Expedition and now Marine Biologist to the Government of Queensland. This work has recently been published,[2] and in addition to much information about the habits and growth of this animal, Mr. Moorhouse states that it appears " to be a winter-breeder, the season extending from March to July at least, and each animal possesses a protracted spawning period ". During this period the surface temperature of the water round about Low Isles where these observations were made ranged from about a maximum of 28° C. in March to a minimum of about 20° C. in July.

Dr. Amirthalingam does not give any temperature figures in his letter, but states that spawning begins in the Andaman Seas in April when the temperature is near the maximum for the year before the outbreak of the south-west monsoon. He will doubtless give full temperature records in his final report, which, with Mr. Moorhouse's paper, should go far towards the full elucidation of the bionomics of *Trochus niloticus*, information urgently required in view of the great economic importance of this animal.

C. M. YONGE.

Marine Biological Laboratory,
Citadel Hill,
Plymouth, Aug. 10.

[1] NATURE, **130**, 98, July 16, 1932.
[2] Moorhouse, F. W., 1932. " Notes on *Trochus Niloticus*." G. Barrier Reef Exped., 1928–29, Sci. Repts., Brit. Mus. (Nat. Hist.) III., pp. 145-155.

Prevention of Blight in Seed Potatoes

IN Jersey, seed potatoes are usually dug when the haulms are green. If blight (*Phytophthora infestans*) is present on the foliage at this time, serious losses may occur in the seed boxes owing to the fungus spores falling on the tubers at digging-time. Losses of fifty to seventy-five per cent are not uncommon.

Experiments carried out at the States Experimental Station, Glenham, have shown that this loss may be almost entirely eliminated by dipping the 'seed' twice, soon after digging, in a 1 per cent dilution of formaldehyde (1 pint of 40 per cent formaldehyde in 99 pints of water) or in a neutral mixture of copper sulphate and caustic soda (4 : 1¼ (about) : 40). Preliminary trials have indicated that dipped and undipped 'seed' sprout equally well.

The method is being tried on a large scale this year. The tubers are dug, placed in the seed boxes, and taken to the farm the same day, where they are dipped before being stored. Four men are able to unload, dip, and stack 360 boxes of seed in one hour.

T. SMALL.

States Experimental Station,
Glenham, Jersey, C.I.,
Aug. 15.

Sir Richard Threlfall and Sir Horace Darwin

MANY of us have read with much interest the understanding obituaries of Sir Richard Threlfall that appeared in NATURE of Aug. 13. Both obituaries dwell on his inventiveness and powers of work. When looking through some old papers to-day, I found a letter from Sir Richard to his friend the late Sir Horace Darwin. In the course of a conversation on a continuous gas calorimeter, which must have taken place about 1900, Darwin suggested that it was advisable to link up automatically the quantity of water heated by the gas flame with the quantity of gas burnt. Threlfall did this, and obtained a recording calorimeter which was far in advance of any other instrument for many years. The letter was evidently written by Threlfall to Darwin after one of the concentrated periods of work referred to in the first obituary notice. It was accompanied by a clear sketch and notes in Threlfall's handwriting.

" Birmingham,
April 7th, 1903.

MY DEAR DARWIN,

Let it be granted that I am an ass—this will prevent your being able to claim to have discovered it after reading the rest of the letter. I have been looking out for more than a year for a neat mechanism to replace that hydraulic gear I use with my instruments, but I never really tried at it till last Sunday, and I was lucky enough to get a very simple device. I think it might work in with some of your things, the recorder, *e.g.*, so I will tell you about it, please regard it as a sort of exchange (a poor one I know) for your hints on the gas meter. The problem was :

Given one clock, and the power of making two electric contacts : to operate a shaft by the clock in either direction of rotation, to lock the clock when neither contact is made. Also the magnets worked by the contacts must not require too much current; the inertia of everything must be small so as to start and stop quickly.

I hope you may find the thing of use—I never knew a simple device which had all the advantages at once and consistently—before.

Yours very truly,

R. THRELFALL."

The sketch and notes were made by a man who was a mechanic, and were sent to one whom Threlfall knew would appreciate and approve of small but important points in design.

I think it will be agreed that the letter shows a delightful spirit of friendship between the two distinguished inventors.

ROBERT S. WHIPPLE.

45 Grosvenor Place, S.W.,
Aug. 18.

A Possible Connexion between the Troposphere and the Kennelly-Heaviside Layer

SEVERAL experimenters have noticed the existence of a correlation between alterations in the propagation of radio waves and the establishment of certain meteorological situations: but, until now, no definite result could be obtained. I have therefore investigated directly the relation of the Heaviside layer, on which the propagation of radio waves depends, to meteorological conditions.

From May 1931 until June 1932, I made, at short intervals, daily observations on the reflection height of waves of 100 metres in wave-length by means of a device invented by me some time ago.[1] The waves of 100 metres wave-length, as is well known, are generally reflected in the E region during daylight, and generally from some time just before or after sunset until sunrise their reflection takes place in the F region.

The time near sunset when the reflection is passing from the E region into the F region often presents remarkable variations from one day to another: the reflection from the E layer sometimes continues for a long time after sunset, until midnight even, for waves of 70-50 metres wave-length; at other times, after disappearing by sunset, reflection appears again a few hours after sunset itself. This is evidence of the existence of remarkable increases of ionic density in the E region, even after the action of ionising solar radiations has ceased. The examination of the data which were obtained from about 330 days' observations has led to the following conclusions:

The abnormal increases of ionic density in the E region are accompanied by particular isobaric situations, characterised by the presence of barometrical depressions at the place of observation or in the north of it. In anticyclonic conditions, or conditions with depressions in the south, the reflection of 100 m. waves from the E region ceases in the shortest time; from noon onwards ionic density gets rapidly smaller. In 330 days' observations I found only some ten exceptions to the above general rules.

The existence of a connexion between the troposphere and the first ionised layer (E) is therefore clearly suggested; its nature will be the subject of future investigations.

IVO RANZI.
Institute of Physics,
University of Camerino, Italy,
July 25.

[1] *Nuovo Cimento*, **8**, No. 6, p. 258, July 1931.

An Optically Active Inorganic Salt

IN 1914, Werner[1] described the resolution into optically active forms of dodecammine-hexol-tetracobaltic hexabromide, $[Co[(HO)_2Co(NH_3)_4]_3]Br_6$. This has remained until recently the only example of an inorganic (that is, carbon-free) salt the molecular dissymmetry of which has been proved by optical resolution. A second optically active inorganic salt, which, although also of the 'complex' type, is of much simpler composition than Werner's salt, has now been obtained.

Sulphamide, $H_2NSO_2NH_2$, has long been known to act as a weak dibasic acid. When certain rhodium salts are treated with sulphamide dissolved in sodium carbonate solution, co-ordination occurs with the formation of sodium di-aquo-rhodium-disulphamide, $Na[(H_2O)_2Rh(HNSO_2NH)_2]$, a compound of the 'diammino-tetracido' type in which each sulphamide residue occupies two co-ordinate positions. This salt should be capable of existence in two isomeric forms, one having the two water molecules in the 1 : 2 or *cis* positions in the six-co-ordination octahedron, and the other having these molecules in the 1 : 6 or *trans* positions. The first isomeride is dissymmetric, and should be resolvable into optically active forms, whilst the second possesses a plane of symmetry and should be non-resolvable.

When an aqueous solution of this sodium salt was treated with *dextro*-nor-ψ-ephedrine sulphate, the alkaloid salt of the complex anion was slowly precipitated; the first fraction thus obtained, on treatment with sodium hydroxide, gave a *lævo*-rotatory sodium salt having, for the mercury yellow line, $[\alpha] = -9{\cdot}6°$ and $[M] = -34°$. Treatment of the racemic sodium salt similarly with *dextro*-phenyl-ethylamine hydrochloride gave the amine salt, which in turn furnished a dextro-rotatory sodium salt having $[\alpha] = +8{\cdot}9°$ and $[M] = +31°$. Although it is not claimed that these represent the optically pure enantiomorphs, the resolution proves the presence of the 1 : 2 or *cis* isomeride in the sodium diaquo-rhodium-disulphamide.

Platinum compounds of similar composition have also been prepared, and their resolution is now being investigated.

F. G. MANN.
The University Chemical Laboratory,
Cambridge, Aug. 22.

[1] *Ber.*, **47**, 3087; 1914.

Dimensions of Fundamental Units

THE recent world-wide discussions upon the electrical and magnetic units and their dimensions have focused attention once more upon the discrepancies which occur in the various textbooks. It has always seemed to me that there was no justification for regarding the three magnitudes, mass, length, and time, as necessarily fundamental, and a system in which quantities expressed in those dimensions have fractional indices is unsatisfactory. If we take the course of regarding quantity of electricity as a fundamental, and introduce Q for its dimension, we get the following table:

Quantity.	Dimension.
Quantity	Q.
Current	$Q.T^{-1}$.
Magnetising force	$Q.T^{-1}.L^{-1}$.
Magnetomotive force	$Q.T^{-1}$.
Magnetic Flux	$M.L^2.Q^{-1}.T^{-1}$.
Flux density	$M.Q^{-1}.T^{-1}$.
Permeability (μ)	$M.L.Q^{-2}$.
E.M.F.	$M.L^2.Q^{-1}.T^{-2}$.
Resistance	$M.L^2.Q^{-2}.T^{-1}$.
Sp. Ind. Capacity	$Q^2.T^2.M^{-1}.L^{-3}$.
Pole strength	$M.L^2.Q^{-1}.T^{-1}$.

It will be noticed that the introduction of a new dimension has automatically wiped out all fractional indices; but this is not all. Examination of the dimensions shows that wherever Q appears in the numerator, M appears in the denominator and vice versa. Consequently, if M be regarded as a function of Q, the former would disappear entirely from the table, and everything in mechanics, as well as in electricity and magnetism, could be put in terms of Q, L, and T.

Further, on the assumption that magnetism is due to spinning electrons, we obtain for μ the expression $\mu = \tau eh/4\pi m$, where τ is a pure number. Here again, then, on the above assumption, Q and M will cancel.

It seems to me that these simplifications are too striking to be merely a matter of coincidence.

WILLIAM CRAMP.
The University,
Edgbaston, Birmingham,
Aug. 9.

Research Items

The Towednack Gold Hoard.—The affinities and dating of the hoard of gold objects found at Towednack, Cornwall, in December 1931 and May 1932 (see Nature for Jan. 16, 1932, p. 90) are discussed in *Man* for August by Mr. Christopher Hawkes. Nine pieces were found, of which four are finished ornaments, two torcs, and a pair of bracelets. Two bracelets are unfinished and the remaining three pieces are bent rods or bars, evidently a goldsmith's raw material. No. 1 is a large torc, 45 inches in length, with enlarged terminals, circular in section, tapering inwards. The main portion is triangular in section and twisted from right to left. The whole is coiled double, and the terminals twisted for interlocking. No. 2 is a triple torc of a pattern hitherto unknown in prehistoric gold work, the body of the torc being formed of three strands of gold wire, each of triangular section and twisted like No. 1. The strands are welded together at the ends to form the terminals, which are bent back to interlock. It measures 4-4½ inches across. Nos. 3 and 4 are a pair of bracelets, quite plain, formed of rods circular in section, bent in an oval penannular form. They are excellently finished, smoothed, and polished. Nos. 5 and 6 are obviously unfinished, awaiting smoothing and polishing, but clearly intended to be quite plain like the previous pair. Of the rods, one is lozenge-shaped in section, the others irregular. There is no reason to think the gold is not of Wicklow origin. The two torcs obviously provide the firmest basis for chronology, and although the second is without parallel, its complexity of structure and fineness of workmanship point to an advanced stage in the development of torc manufacture. The simpler workmanship of No. 1 invites an abundance of comparative material, and an examination in detail of torc types suggests that it is a developed type, but earlier than the fully established Late Bronze Age types, for example, the Morvah hoard, and preceding the full establishment of the Late Bronze Age culture in Cornwall and Ireland. It belongs, then, to the period 1000–750 B.C., a period of transition, perhaps marking a renewal in the Irish-Cornish gold and tin trade.

Menominee Indian Music.—In a report on an investigation of the music and song of the Menominee Indians of Wisconsin (*Bull.* 102, Bureau of American Ethnology), Miss Frances Densmore records a close resemblance in ceremony and custom, as well as in the songs accompanying them, to the Chippewa. The medicine lodge of the Menominee is practically identical with the Grand Medicine Society of the Chippewa; and in the drum ceremony, which originated with the Sioux and is thought to contain elements of Christianity, the observances of the Menominee are closely akin to those of the Chippewa. On the other hand, in the use of war-bundles and hunting-bundles and in the morning star legend, they resemble the Winnebago. The songs recorded are mostly of a ritual character; but there are also love songs and lullabies. Some of the songs are those used in connexion with the ritual games, the bowl-and-disc game, the double-ball game, and lacrosse, which are played ceremonially for the benefit of a person who has dreamed a dream. The ceremonial character of the game is indicated by the fact that it is immaterial which side wins. Songs sung in connexion with adoption dances are recorded, as well as a number connected with treatment of the sick. Underwater and underground powers are frequently mentioned in connexion with the songs. Chief among the latter is the ‘ underground bear ’, a white bear larger than a grizzly, said to be an ancestor of the Menominee tribe. It emerged from the ground as an Indian near the present site of Marinette, Wis., and was followed by more Indians. The chief of the ‘ underwater ’ powers is the ‘ underwater snake ’, usually referred to as the ‘ hairy snake ’, which lives in the water and personifies the powers of evil. If the body of anyone who has been drowned is found in an upright position, it is believed that he has been drawn down to his death by the underwater snake.

The Arthrodira.—Of recent years there has been a considerable accession to our knowledge of the Arthrodira. This group of Devonian fish-like animals has had a chequered career in regard to its zoological position. At first regarded as water beetles, these animals next became reptiles, and at length were recognised as fishes of some kind. Recently, Stensiö in an important paper on the head of *Macropetalichthys*, in which a very detailed account of the elasmobranch-like brain structure is given, came to the conclusion that the Arthrodira as a whole were true fishes and represented an early offshoot of the elasmobranch line. The most recent pronouncement on the subject is by Heintz (Anatol Heintz, "The Bashford Dean Memorial Volume", Article 4, 115-224. American Museum of Natural History, 1932). This investigator not only denies the elasmobranch relationship of the Arthrodira, but, while agreeing that *Macropetalichthys* is elasmobranch in affinity, also disputes its connexion with the Arthrodira. If this be the case, then the evidence of the elasmobranch affinity of the Arthrodira, based as it is chiefly on the structure of *Macropetalichthys*, falls to the ground. Heintz returns to an older view that the Arthrodira (together with the Antiarchi) form a separate group unconnected with any other group of fishes, and one which is perhaps not to be considered as formed of true fishes at all. They are ranked therefore as a class equivalent to the classes Agnatha (Cyclostomata) and the Pisces, and the name Placodermata, given by McCoy in 1840, is restored. The chief character on which this view is based appears to be the structure of the jaws, which is *sui generis* and unknown in any other form of animal.

High-Moor Vegetation of Eastern Prussia.—Dr. Reimers and Dr. Hueck have recently given an account of the high-moor vegetation of eastern Prussia (*Abhand. d. Math-naturw. Abt. d. Bayer Akad. d. Wiss.* Suppl.—Band 10 Abh. Munchen 1929, pp. 407-494, 12 plates, 2 maps, and 14 text figures). This is of an extensive rather than intensive character, based on the examination of a number of examples for which species lists are furnished and relative frequencies given. Most of the moorland communities described appear to conform in general terms with the zonal communities presented in the moorland of Ezeretis. Here open water occupied by *Nymphœa* and *Nuphar* is succeeded by a community in which the dominants are *Carex limosa–Scheuzeria palustris* and *Oxycoccus vulgaris*. The last-named is also common in the next zone dominated by *Rhynchospora alba*. A drier community is characterised by *Andromeda polifolia–Drosera anglica* and *Sphagnum rubellum* (in contrast to *S. cuspidatum* in the preceding zones). The driest area is occupied by *Calluna* heath, which in its damper parts is associated with *Ledum palustre* and *Rubus chamœmorus*, whilst in its drier parts colonisation by *Pinus sylvestris* may take place. Low moor vegetation also occurs locally with *Menyanthes trifoliata*, *Ranunculus lingua*, *Peucedanum palustre*, *Comarum palustre*, *Aspidium thelypteris*, etc. A number of transition types are described; also several woodland communities, the status of which is not quite clear.

Inheritance of Resistance to Wilt Disease in Cotton.—An investigation of the resistance of Egyptian cotton to the wilt disease (*Fusarium vasinfectum*), and its inheritance, has been made by Dr. Tewfik Fahmy (*Bull.* No. 95, Ministry of Agriculture, Egypt). He classifies plants as susceptible, resistant, or immune according to whether they die as seedlings in infected soil, recover after developing mottled leaves, or show no symptoms. Some Egyptian varieties are completely susceptible, while others show a percentage of resistance and immunity. In crosses, immunity is dominant to susceptibility. The F_2 in one cross (Giza 7 × Sakha 3) gave 75 per cent immune, 15 per cent resistant, and 10 per cent susceptible. The immunes may segregate or breed true. The resistant plants in F_3 may give all three types or only immune and resistant. In a cross between susceptible and immune, there is an increase in the resistance of susceptible plants, as measured by the incubation period before the symptoms of the disease appear. Also, mother plants with a long incubation period have a higher percentage of immune progeny than those with a shorter incubation period, which are therefore less resistant. The correlation between susceptibility and length of fibre has also been studied.

Slime Moulds in Soil.—"The Distribution of Dictyostelium and other Slime Moulds in Soil" (K. B. Raper and Chas. Thom, *J. Wash. Acad. Sci.*, 5, 22, No. 4, pp. 92-96, 1932) describes the occurrence in soil of various members of the Acrasieæ, a group of fungi closely related to the Myxomycetes, but which reproduce by means of amœbæ and have no flagellate stage. The organisms described belong to the genera *Dictyostelium* and *Polysphondylium*, and have hitherto been regarded as manure-inhabiting fungi. The present report shows that they are a normal part of the soil micro-flora, and clears up one of the puzzles as to the identity of the amœboid forms found in soil. The use of suitable culture methods will probably show that many of the so-called amœbæ in soil are only stages in the life-histories of such fungi.

Geology of Uganda.—The Annual Report of the Geological Survey Department of Uganda for 1931 (Entebbe, 1932, pp. 20) records many features of geological interest. Mr. W. C. Simmons has discovered a true unconformable sedimentary junction between the Karagwe-Ankolean beds and the underlying basement complex. Dr. A. W. Groves has proved the existence in Uganda of a charnockite series closely paralleling that of India. As in India, some of the occurrences are associated with magmatic iron ores and graphitic schists. The chromium-bearing mica, fuchsite, has also been found in the charnockite areas. Dr. Groves records the effects of shearing movements on the crystalline rocks on both sides of Lake Albert. He finds that the degree of brecciation, granulitisation, and mylonitisation is related to the distance of each specimen from the nearest rift scarp, and reaches the conclusion that the disturbances bringing about the formation of the Albertine rift valley were responsible for these shearing effects. The observations thus support the compression hypothesis of rift-valley formation. They also imply the removal of a considerable overburden by denudation, corresponding to the accumulation of thick deposits in the Albertine depression. The tectonic activity which gave rise to the rift, and is probably still in progress, must therefore have begun long ago. It is announced that Mr. Combe has completed his memoir on the tinfields of Ankole. The finding of cobalt and nickel-copper ores on Ruwenzori is also recorded.

Distribution of Earthquake-Centres in the Philippines.—Father W. G. Repetti, *S.J.*, who recently studied the distribution of Philippine earthquake-centres north of Manila during the years 1920–29 (see NATURE, **129**, p. 367 ; 1932), has continued his work on those lying to the south of the capital. During the same ten years, there were in this region 102 earthquakes, the epicentres of which could be determined with accuracy by means of seismographic records. With one exception, all these epicentres were submarine. The most important zone is the ocean trough known as the Philippine Deep lying off the east coast of Mindanao. Epicentres are concentrated in two principal areas, one in lat. 6° 30′ N., long. 126° 40′ E., the other in about lat. 7° 45′ N., long. 127° 10′ E., both lying between 25 and 30 miles east of Mindanao.

Gas Burner Design.—The Bureau of Standards at Washington, in co-operation with the American Gas Association, has been engaged for some time determining the conditions which limit the efficient operation of gas burners of various types using gases of many different compositions, and the results so far obtained are embodied in a paper by Messrs. J. H. Eiseman, E. R. Weaver, and F. A. Smith in the June issue of the *Journal of Research*. In it the conditions which were indicated qualitatively in Circular No. 394 of the Bureau are specified quantitatively for a domestic burner of the 8-prong star type with 44 jets. For each rate of supply of gas measured in British thermal units per hour per jet, the percentage of the total air necessary for complete combustion which must be mixed with the gas before it arrives at the jet, and which on one hand will prevent a yellow tip and on the other neither produce a flash back nor a blow out, is shown by curves for jets of various diameters. The influences of the height above the jets of the utensil to be heated on the production of carbon monoxide and on the efficiency of the burner are also shown.

Crystalline Structures in Glasses.—Lord Rayleigh has published a set of photographs of various glasses, taken between polarising nicols, which show the presence of particles and threads, in size very approximately of the order of a millimetre, having crystalline structure not due to mechanical strain (*Proc. Roy. Soc.*, July). These had been previously found in fused quartz and a phosphate glass known as Corex, and were likened to the Lehmann structure in liquid crystals. They are not present in silica glasses which have not a large silica content, the limiting quantity being about 80 per cent, as in Pyrex. Silica is also not essential for their production, as they may appear in phosphate and borate glasses. When present, they naturally make the material incompletely isotropic, and their complete removal presents an interesting, if not indeed an intractable problem. The effect is possibly connected with the devitrification of glasses and the crystal structure found in them by means of X-rays.

Protein Monolayers.—Investigations of proteins as monomolecular films on liquids, a method previously attempted with indifferent success, has now been developed satisfactorily by E. K. Rideal and A. H. Hughes (*Proc. Roy. Soc.*, July). In the earlier work, the films formed were probably not homogeneous ; in the present work, homogeneous films of known weight have been made by depositing a fragment of the protein from the tip of a delicate quartz fibre microbalance. These films were then examined by compressing them on the surface in a Langmuir film apparatus, as well as electrically and optically. Gliadin, with which most of the work was done, gave homogeneous films with a thickness so low as 3 A., which changed on compression to a form having many of the properties of a gel, and quite possibly the two-dimensional analogue of this state of aggregation. It is supposed that the basic polypeptide chains of the protein are stretched out flat on the surface in the most expanded state of the film, and that on compression and gelation the side chains to the main polypeptide chain are forced out of the surface.

The Heavy Hydrogen Isotope.—Of several recent papers on H^2, one by E. W. Washburn and H. C. Urey (*Proc. U.S. Nat. Acad. Sci.*, July) is of outstanding importance in indicating a possible electrochemical method for separating it in quantity. In electrolysis, there will probably always be some difference between the electrode properties of different isotopes of the same element. Generally, this will be small, but with hydrogen it is apparently significant, and in the electrolysis of water the residual liquor should perhaps contain a marked excess of the heavy isotope. A long experiment to test this is in progress at the United States Bureau of Standards, but meanwhile some commercial residues have been examined, and show the expected enrichment qualitatively. Other chemical reactions might produce a similar change in the relative amounts of H^2 and H^1, and the problem of their relative abundance in Nature is thus complicated by the history of the hydrogen-containing substances investigated. In the first July number of the *Physical Review*, the concentration of H^2 in 'ordinary' hydrogen is estimated to be about 1 in 30,000 by W. E. Bleakney, from mass-spectrum measurements, and the mass of H^2 is given as $2{\cdot}01353 \pm 0{\cdot}000064$ by K. T. Bainbridge; no evidence for the presence of helium isotopes could be found by the former.

Colour and Mineral Content of Honey.—Analyses of several specimens of American honey by Schuette and Remy (*J. Amer. Chem. Soc.*, July), in which special attention was given to the presence of manganese and copper, on which emphasis has been laid by students of nutrition, have given interesting results. The analyses of twenty-two specimens of honey, of which eighteen were taken directly from the comb, showed that the mineral content of the dark-coloured varieties was higher than that of the light-coloured. The manganese and copper contents were also higher in the darker-coloured honey. The average percentage of ash in the light honeys was 0·06, that in the dark honeys 0·17. The light honeys contained an average of 0·29 mgm. copper and 0·30 mgm. manganese, the corresponding values for the dark honeys being 0·56 mgm. and 4·09 mgm. The maximum figures were 0·70 mgm. copper and 0·44 mgm. manganese for light honeys, and 1·04 mgm. copper and 9·53 mgm. manganese for dark honeys. The characteristics and flavour of honey are probably influenced to a marked degree by nectar and pollen. They, in turn, may well vary in composition and quality according as the plant which produced them is affected by such growth factors as the meteorological conditions prevailing in its habitat and the nature and fertility of the soil. It is suggested that a dark honey should have a higher nutritive value than a light one, although colour and quality often bear an inverse relationship to each other in the lay mind.

Astronomical Topics

The Corona without an Eclipse.—*L'Astronomie* for June contains an article by M. B. Lyot, giving further particulars about his results obtained at the Pic du Midi. He states that the brightness of the inner corona is about equal to that of the planet Mars, which is readily visible in daylight; but observation of the corona is rendered more difficult by the great brightness of the sky near the sun; this is, however, greatly diminished at a height of 10,000 feet, especially when cloud and dust are absent; a further difficulty, due to diffused light in the telescope, is diminished by keeping the lenses quite free from dust, and by placing diaphragms in the tube, slightly larger than the solar image, to shut off sunlight. In order to distinguish instrumental defects from genuine solar markings, the coronagraph was rotated slightly between exposures; instrumental markings remain in the same place on the plate, but solar ones follow the solar image. Using a red screen, it was possible to view prominences directly, without a spectroscope; a Wratten screen, transmitting light between wave-lengths 6500 and 6600, permitted photographs to be taken of coronal jets, rising to a height of 7′ above the sun's limb.

M. Lyot gives measures of the wave-lengths of the green and red lines in the coronal spectrum; the plates were measured at Meudon by M. H. Grenat, who found for the green line 5302·83 on the east of the sun and 5302·87 on the west; the difference is in the right direction for rotation, but no stress is laid on this. The line in the red, which was traced to a height of 6′ above the limb, gave wave-length 6374·75, but with a probable error of 0·15. Unsuccessful attempts were made to photograph other lines at 4232, 4086, and 3986, which had been obtained from eclipse photographs.

M. Lyot notes, in conclusion, that sunspot activity was decidedly low when these results were obtained; he hopes for better results near maximum. He makes the observation that much longer exposures can be given than during eclipse.

Sunspots and Comet Activity.—De Morgan in his "Budget of Paradoxes" describes as a joke a correspondence between Pons and von Zach, in which the latter humorously explained Pons's failure to find comets during a certain period by noting that sunspots had also been absent then; Pons took this seriously and made a successful search for a comet after the return of large sunspots. De Morgan adds, "It would mend the story exceedingly if some day a real relation should be established between comets and solar Spots". Something like this suggestion has now actually come to pass. *Popular Astronomy* for May contains an abstract of a paper by Messrs. Hulbert and Maris, which brings forward many striking instances in which unusual solar activity has synchronised with remarkable phenomena in comets visible at the time. It is not the first time that the suggestion has been made. It was noted that the activity of Morehouse's comet in September 1908 came at a time of spot activity; the greatest magnetic storm of the year occurred on Sept. 11; many people thought then that the two events were connected. Indeed, since all cometary activity is now ascribed, directly or indirectly, to solar action, it is quite to be expected that the action of the sun on comets should depend on its state of activity.

Hulbert and Maris note that there were magnetic storms in the autumn of 1835, when Halley's comet exhibited striking changes, and again that a great storm occurred on Dec. 3, 1846, a few days before Biela's comet split in two. Of course, the solar activity does not bring comets, but it may well increase the brightness of those that happen to be there, and so increase the chance of discovery. It thus appears that the jest of von Zach may be taken in earnest.

The Solar Chromosphere *

THE spectrum of the solar chromosphere may be observed at a time of total eclipse by various methods. Frequently the thin crescent of the solar gases is photographed through a prismatic camera, the crescent itself acting as slit. In 1898, Dr. W. W. Campbell devised an important modification of this method of observing the flash spectrum. It consisted in the introduction of two new features, (1) a wide slit in the focal plane of the camera perpendicular to the dispersion and so to the monochromatic image-crescents, (2) a moving photographic plate moved during the exposure in its own plane in a direction perpendicular to the slit. The slit permits a short length (of the order of $\frac{1}{32}$-inch) of the central portion of each crescent to fall on the plate.

In the resulting photograph each bright line in the usual flash spectrum appears as a longer or shorter bright line, straight and normal to the dispersion, terminating at one end at a point corresponding to the instant at which the whole radiation from the still uncovered chromosphere is insufficient to affect the plate. In the other direction each bright line ultimately 'fades' into the corresponding Fraunhofer absorption line.

The intenser the radiation from the chromosphere for a given distribution of intensity with height, the longer the line outside the apparent limb-level; and similarly the less rapidly the intensity decreases with height, the longer the line. The apparent limb-level is well marked in the photographs, and it is possible to analyse the spectrum from the moving-plate spectrogram at any assigned 'height' on the plate, but it must be remembered that the 'intensity' at any given 'height' on the plate is a function not of the chromospheric radiation at that height but of the integrated chromospheric radiation for all levels above that height. Thus the spectrograms are not what they appear to be at first sight, and some mental effort is required to keep the true interpretation vividly in mind.

The method was successfully employed by Campbell at the eclipses of 1898, 1900, 1905, 1908. Though these results were described in brief immediately after each eclipse, full details waited until the present. We now have, in this splendid volume from the Lick Observatory, the complete analysis of the chromosphere results by the moving-plate method and a series of reproductions of the spectrograms. The work has been carried out by Dr. Donald H. Menzel, and he is to be congratulated on the service he has rendered to solar physics.

In the introduction, Dr. Campbell defends the moving-plate method against criticism, and points out its advantages as a *continuous* record of the changes in the flash spectrum as the chromosphere is gradually covered or uncovered by the moon. Approximately two-thirds of the volume is occupied by spectroscopic tables, computed by Menzel. These tables give possibly the most complete information on the flash-spectrum yet published. The whole of the measures are arranged twice over, once according to wave-length and then again arranged according to element, the full multiplet designation being given for each line, together with estimates of its 'intensity' at various 'heights' as measured by microphotometer tracings. The labour of compilation must have been immense, and the double tabulation will enormously smooth the paths for future workers.

Dr. Menzel reaches the surprising conclusion that the contours of all chromospheric lines at any given level are essentially the same curve, the vertical scale only being different; and further, that the contours are broader and more flattened at the higher levels. As Menzel says, this is the reverse of what would be expected. Insufficient information is given about the apparatus employed, etc., to form a judgment whether the effect is real or simply a photographic effect. The reproduction of a few microphotometer tracings would have been of interest.

The remaining one-third of the volume is a valuable digest of current theories of contours of spectral lines in stellar atmospheres, degrees of ionisation, etc., together with various applications to the results of the chromospheric observations. It is extremely useful to have a consistent treatment of the whole problem; and Dr. Menzel's analysis is in many places original. His final conclusion (stated with critical reservations) is that the chromosphere is probably in a state of turbulence in which radiation pressure plays a part. He criticises the attribution to the chromosphere of a static form of equilibrium under radiation pressure, but it may be noted that he ultimately shows (p. 286) that Minnaert's observed value of the residual central intensity in the ionised calcium lines is consistent with an almost 'fully-supported' chromosphere. Dr. Menzel's analysis is throughout directed towards an attempt to infer what is the actual state of the chromosphere as implied by observation; he is not in general concerned with the more fundamental problem of why the chromosphere comes to have its particular state. Some of the theories of chromospheric equilibrium which he views unfavourably owed their origin to an attempt to see in what ways it is possible for a stellar atmosphere to thin out into space, how radiation pressure rises into importance as collisions become rarer, and similar problems, rather than to impose a particular theoretical constitution on the solar layers. But Dr. Menzel's whole outlook is stimulating, and his volume will be a rich treasure-house, of both observation and theory, to all future workers on the subject.

E. A. M.

* Publications of the Lick Observatory, Vol. 17. Part 1: A Study of the Solar Chromosphere based upon the Photographs of the Flash Spectrum taken by Dr. William Wallace Campbell, Director of the Lick Observatory, at the Total Eclipses of the Sun in 1898, 1900, 1905 and 1908, by Donald H. Menzel. Pp. v+vi+303+9 plates. (Berkeley, Calif.: University of California Press, 1931.)

Resuscitation in Asphyxia

THE recovery of persons in whom breathing has ceased following the inhalation of water or a noxious gas is attempted by artificial respiration, the method most generally adopted being the Schäfer prone pressure method. In certain cases, however, this method may not be suitable, or it may be inadequate to restore the normal respiratory movements. In collapse on the operating table under an anæsthetic, the cessation of breathing is sometimes quickly followed by stoppage of the heart: recovery may follow artificial respiration alone, or after cardiac massage or the injection of adrenaline into the heart in addition.

An experimental basis for the use of adrenaline is given by the results obtained in a recent investigation by Sir E. Sharpey-Schafer and W. A. Bain (*Proc. Roy. Soc. Edin.*, vol. 52, p. 139; 1932). Cats anæsthetised with urethane were asphyxiated by occlusion of the trachea: the respirations became slower, and later deeper as well, and finally ceased: about a minute later a series of gasps occurred, which were usually ineffective in restoring the circulation (the trachea having been opened) unless the heart was also beating. The blood pressure fell when respiration ceased, and the heart gradually stopped.

Manual pressure on the chest may now cause recovery, both by renewing the air in the lungs and by pumping blood through the heart; artificial ventilation of the lungs alone may fail. The blood pressure may rapidly rise to an abnormal height before settling to the normal level, probably due to passage of adrenaline in the stagnant venous blood through the heart and arteries. The injection of adrenaline into the heart, especially the myocardium, will restore the beat to normal if the organ is beating feebly, or will arouse it again if given fairly soon after stoppage, together with inflation of the lungs. At the same time, it constricts the arteries and raises the blood pressure to its normal level or even higher. With restoration of the circulation, the breathing also returns, and though at first slow and deep, gradually becomes normal in character and rate. The injection of adrenaline into the heart, together with artificial respiration, will only be successful in the human being provided the breathing and circulation have not been too long in abeyance; ten minutes is probably the limit in ordinary circumstances.

The manual method of artificial respiration is inconvenient and difficult to apply successfully over a prolonged period of time; P. Drinker and L. A. Shaw have invented a mechanical respirator for use in the respiratory paralysis of anterior poliomyelitis in children and in cases of respiratory failure due to carbon monoxide poisoning, electrocution, drowning, etc. (*J. Franklin Inst.*, vol. 213, p. 355; 1932). The patient is placed, except for his head, in a closed chamber; the neck is encircled by an air-tight flexible rubber collar. Air is rhythmically pumped from the chamber, producing inhalation in the patient; exhalation occurs when the air pressure returns to normal. The patient's respiration is completely under the control of the machine when the negative pressure is 7 cm. of water. The apparatus has been found so successful that more than 150 are now in use in the United States and Canada. It is of interest to note that the optimum diameters of the rubber collar and head hole in the lid were obtained by plotting frequency curves from manufacturers' sales of different sizes of collars and hats.

Cosmic Radiation

IN a paper presented at the recent International Electrical Congress held at Paris, Prof. R. A. Millikan summarised in a convincing manner his views concerning the nature and origin of the penetrating cosmic radiation. The idea that they are neutrons, although it would combine the advantages of particles with failure to be deflected in the magnetic field of the earth, he considers unnecessary and not superior to the photon hypothesis. Commenting on the experiments which have been made to find if there is any preferential direction in which they enter the air, Prof. Millikan takes the view that there is no evidence that they are other than isotropic; this is in accord with his interpretation of their absorption curve, according to which the cosmic rays arise from processes involving the agglomeration of hydrogen nuclei for, probably, a very long time until they condense catastrophically to form a new nuclear type, which could scarcely occur where the temperature and pressure were not extremely low, as in interstellar space.

This paper contains some details of the experiments which have been made by Anderson in the Norman Bridge Laboratory in California, with a Wilson expansion chamber. The main aim of these was to deflect the products of the interaction of the rays with matter in a magnetic field, but many interesting subsidiary observations have been made.

The cosmic rays appear to be absorbed largely by nuclei, in general accord with the supposition that they arise in nuclear processes, but destroying the validity of the immediate application of the Klein-Nishina absorption formula, which assumes interaction with the extra-nuclear electrons. About thirty good trails have been photographed. Eleven show a proton with an energy of the order of some 10^8 electron-volts, two an electron of similar energy, three protons of between sixteen and forty million volts, five electron trails of about ten million volts, and the remainder particles of greater energy than 5×10^8 volts. The reality of the latter would not be in agreement with Prof. Millikan's atom-building postulates, the energy being excessive, but there is some doubt if they are authentic, as the trails show a number of sudden small deflections which are difficult to reconcile with the transit of such energetic particles. In seventeen per cent of the encounters with nuclei, the latter suffered disintegration.

International Conference on Radio Communication

RADIO engineers are looking forward anxiously to the international conference in Madrid on radio communication, which begins in September. In the *Wireless World* for Aug. 19 and 26, Noel Ashbridge, chief engineer to the British Broadcasting Company, states some of the problems of which a solution will have to be found. He confines himself to the broadcasting problem, and discusses first the problem of separating the frequencies and consequently the wavelengths of the stations in Europe.

The existing agreement, known as the Prague plan, was put into operation by a large majority of the signatories in June 1929. It was decided that, so far as wave-lengths between 200 metres and 545 metres are concerned, the minimum separation between stations should be 9 kilocycles. This number was not selected on technical grounds but because it was the only hope of getting a general agreement. For the first year after the agreement the arrangement worked very well, only a few people who had signed the agreement failing to observe it in practice. During this year there were only a few stations which worked with a higher power than 15 kw.

Serious trouble started in November 1930, when Mühlacker, a high-power station, operated with a frequency adjoining that of London Regional. The result was immediate and severe jamming after dark on the London programme. The condition of affairs was very bad, because two years ago ordinary receivers were not nearly so selective as they are now.

The German engineers showed how the interference in the receiver could be cut out altogether, but the quality of the speech delivered was seriously affected. The solution adopted was to increase the separation between Mühlacker and London to 11 kilocycles. It is proved that if there is to be freedom from interference at the limit of the service area, the reproduction of frequencies of more than about 4000 cycles cannot be obtained and so the reproduction is not good.

It has been said that the response of a loud-speaker up to about 4000 cycles per second is sufficient for most practical purposes, and that, therefore, the interference problem does not now exist. Mr. Ashbridge states that, for really good quality reception, frequencies up to 7000 should be reproduced. A gramophone record reproduces something appreciable up to and a little beyond 5000 cycles, and yet the lack of the upper frequencies is quite noticeable to the critical ear. In future, this will doubtless be much improved. It would be a pity if broadcasting were permanently made inferior to the gramophone. Theoretically, the separation of broadcasting stations should be governed by the band of audio frequencies which it is necessary to cover in order to give full effect to the programmes.

If it is agreed to keep the 9 kilocycle separation, then those living in areas of high field-strength will get good quality service, whilst the others must have the higher frequencies cut off. If it were agreed to have a wider separation, then it would be necessary to reduce the number of stations in Europe as a whole. No one has ever pressed for a larger separation than 11 kilocycles, and experiments show that the range of reproduction can by this means be increased fifty per cent. The question of the limitation of the power of the various stations is a very difficult one. If they are too weak, we have 'fading'; if too strong, we cannot get the higher frequencies. It is difficult to say which is the more objectionable.

Calendar of Geographical Exploration

Sept. 7, 1298.—Marco Polo

According to Ramusio, Marco Polo was taken prisoner by the Genoese in a battle off Curzola in Dalmatia. Whether this was the exact date or not, it is at any rate certain that in 1298 Marco Polo was imprisoned in Genoa and that he there dictated his narrative to his fellow-prisoner, Rustician of Pisa. Marco Polo came of a family of Venetian traders; his father and uncle had visited the court of the Grand Khan, near Peking, on a journey which began in 1255. After their return, they again set out, taking Marco with them, in 1271. They travelled from Acre through Armenia, passed through Bagdad and Basra to Ormuz, turned inland and crossed Persia to Balkh. Thence they travelled across the Pamirs to Kashgar, went through Yarkand and Khotan to the south of Lob Nor, crossed the difficult Ordos desert and reached Peking. They remained in China for seventeen years, and returned by the sea route, a voyage which no European had ever before made from a Chinese port. Of all medieval travellers, Marco Polo is justly the most famous. To the unique opportunities given him by his long journeys and his prolonged stay in China he brought a vivid personality, keen and alert to notice everything of interest in his surroundings. In his narrative he shows a discriminating selection of the crucial facts of the geography and social and economic life of each of the many regions through which he passed. Thus, though six hundred years and more have passed since his book was written, it still holds readers by its charm and insight.

Sept. 7, 1787.—La Pérouse Strait

La Pérouse put in at Petropavlovsk in Kamchatka and thence sent Lesseps overland with the journals, notes, plans, and maps recording the work of his expedition. This foresight saved these most important observations from destruction, for after a letter of Feb. 7, 1788, from Australia, nothing more was heard of him until 1826, when Capt. Dillon found the wreckage of his ships on Vanikoro, an island to the north of the New Hebrides. La Pérouse sailed on Aug. 1, 1785, from Brest, to try to discover the north-west passage from the Pacific side. He reached Mount St. Elias, Alaska, on June 23, 1786, visited the Hawaii group, and discovered Necker Island. Thence he passed to the coasts of Japan, Korea, and 'Chinese Tartary', and discovered the strait between Sakhalin and the northern island of Japan which bears his name.

Sept. 7, 1837.—Adélie Land

The great French explorer, Dumont d'Urville, sailed from Toulon with two vessels, the *Astrolabe* and the *Zelée*, to search for land in the south polar regions. He attempted to follow Weddell's track, but was held up by pack ice and returned to make investigations in the Pacific. On Jan. 1, 1840, the vessels left Hobart, and discovered Adélie Land later in the month. D'Urville's work, both on this voyage and on a former one in 1826–29, added much to our knowledge of the geography of the Pacific, especially of the Fiji Islands, the Carolines, and the Moluccas. He also helped to chart more accurately the coasts of New Guinea and New Zealand. During his 1826–29 voyage he found evidence of the wreck of La Pérouse's vessel, which had disappeared in 1788, on the island of Vanikoro, one of the Santa Cruz group. On a voyage in the eastern Mediterranean he visited the island of Melos, and saw an old Greek statue which had just been unearthed. His keen appreciation of its beauty resulted in the acquisition by the Louvre of the famous Venus de Milo. This artistic sense led him to take the French artist Goupil with him to the antarctic; the resulting illustrations of his journal added much to its descriptive value, as well as to its beauty.

Societies and Academies

PARIS

Academy of Sciences, July 18 (vol. 195, pp. 193-292).—**L. Blaringhem**: Reappearance of fertility in a new variety of wild foxglove (*Digitalis purpurea*).—**Charles Achard, Augustin Boutaric, and Maurice Doladilhe**: The dilution of horse serum in electrolytic solutions. In an earlier paper it has been shown that by diluting 1 c.c. of serum to a volume l and measuring the optical density of the solution (h), then lh increases at first, passes through a maximum, and decreases to a limiting value. This work has now been extended to solutions containing salts.—**Emile Guyénot, W. Bartschi, and Mlle. K. Ponse**: The production of the yellow bodies studied by the method of transplantation of the ovary on to male guinea-pigs.—**J. Schauder**: The problem of Dirichlet generalised for non-linear equations of the elliptic type.—**J. Ottenheimer**: The displacement of water and the nature of the waves recorded in submarine explosions.—**D. Riabouchinsky**: Experimental researches on the formation of cavitations.—**Henri Mineur, Mlles. Renée Canavaggia and Marie-Louise Fribourg**: The correlation between the velocity of the star mass and their distance in the galactic plane.—**René Audubert**: The Debye-Hückel theory and electrophoresis.—**M. Pauthenier, Mme. M. Moreau-Hanot, and R. Guillien**: The charge of small dielectric spheres in an ionised electric field.—J.-J. Trillat and Th. v. Hirsch: The diffraction of electrons by single crystals. The case of paraffin and the saturated fatty acids.—Pierre Girard and P. Abadie: The comparison of experiment and theory of dispersion in the Hertzian domain. The theory of Debye requires modification by the introduction of a factor representing the molecular constitution.—Ch. Haenny: The magnetic double refraction of salts of the rare earths in aqueous solution. Magnetic constants are given for twelve rare earths.—Pierre Tarbès: Method for the study of joining and expansion of glasses. Compensator for double refraction. If two glasses, possessing different coefficients of expansion are joined, the join may part at once, or possibly after several months. The method proposed measures the strains in the join by double refraction, using a special compensator.—Léonard Sosnovski: The polarisation of the fluorescence bands of cadmium vapour.—Q. Majorana: A new photoelectric phenomenon. Thin films of various metals deposited on glass (gold, silver, platinum, tin) show a variation in electrical conductivity on exposure to light. The effect was not observed with thin films of aluminium or zinc (see also NATURE, **130**, 241, Aug. 13, 1932).—Mlle. Y. Cauchois: A new method of X-ray analysis of crystalline powders utilising a monochromator with a curved crystal.—Horia Hulubei: The experimental study of the partial absorption of the X-rays. The author has attempted to repeat the experiments of B. B. Ray, but with negative results.—Pierre Auger: The emission of slow neutrons in the stimulated radioactivity of beryllium.—Francis Perrin: The constitution of the atomic nuclei and their spin.—Mlle. M. Pernot: The system mercuric bromide, potassium bromide, and water.—Henri Muller: The lowering of the eutectic point of ice-potassium nitrate, by acids, bases, and acid salts.—Desmaroux and Mathieu: Remarks on the structure of films of nitrocellulose with high nitrogen content.—Charles Lapp: The rotatory power of quinine in alcoholic solution. The specific rotatory power of quinine in alcoholic solution varies with the concentration. The facts are consistent with the hypothesis that the molecules of dissolved quinine form two groups, one in which each quinine molecule is associated with 40 alcohol molecules, the other group containing free quinine molecules.—Lespieau and Guillemonat: A new isomer of benzene, $CH_2 : CH . C : C . CH : CH_2$.—Jacques Sordes: The absorption in the ultra-violet of the hydrocarbons $(CH_3)_3C_6H_2(CH_2)_n . C_6H_2(CH_3)_3$.—G. Hugel and M. Lerer: The synthesis of alkyl aromatic hydrocarbons. The synthesis is based on the interaction of the hydrocarbon (napthalene, anthracene) with alkyl halide in liquid ammonia in the presence of sodium.—R. Cornubert and G. Sarkis: Contribution to the study of the extinction of the ketone function and the theories put forward to explain this phenomenon.—Lucien Semichon and Michel Flanzy: The application of chromic oxidation to some alcohols.—Jacques de Lapparent: The classification of the sedimentary clays.—Henri Vincienne: The flaky structure of the Ambérieu region (western edge of the southern Jura) and the age of the last Jurassic movements.—Fernand Daguin: A Cretaceous flora in the neighbourhood of Tissa (western Morocco).—Maurice Hocquette and Mlle. Raymonde Villard: The action of saturated ether vapour on the quiescent and dividing nuclei of the seedlings of *Raphanus sativus*.—L. Plantefol: The power of concentration of the cytoplasm. The formation of crystals by pollen grains, starting with neutral red.—E. Miège: The influence of various factors on the development of the inflorescence of cereals.—B. Demetrović: The effect of Mach's law. A discussion on the possibility of this effect being partly physiological and partly physical (diffraction).—G. Tanret: The hyperglycemic action of hordenine sulphate. Hordenine, in sufficient doses, possesses the hyperglycemic action of the true sympathomimetic substances (adrenaline, ephedrin).—Marcel Avel: The experimental analysis of the disappearance of the power of regenerating a head in the middle region of the body in *Lumbricus*.—A. Machebœuf, G. Sandor, and C. Nini: Physico-chemical studies on the filtrates of acid-resisting bacilli of tuberculosis and of fleole.—Mme. L. Gruzewska: The α-lipase and amylase in the blood of some Crustacea.—G. Champetier: The fixing of water by cellulose. By a physico-chemical method, it is shown that cellulose fixes half a molecule of water per hexose group ($C_6H_{10}O_5$), whilst mercerised coaltar fixes double this amount.—Maurice Piettre and André Guilbert: The influence of electrolytes, especially sodium chloride, on the proteins of serum. The dispersion of myxo-protein in solutions of common salt cannot be explained by an adsorption of salt by the protein.—Jacques Parrod: The oxidation products of levulose in ammoniacal solution by methylene blue and atmospheric oxygen, at laboratory temperature. The products of this oxidation were 4- methoxy imidoazol, *d*-4- arabinotetroxybutylimidoazol, and a new substance imidoazol-4-formamide.—Jean Cheymol and Alfred Quinquaud: The exchanges of normal calcium in dogs deprived of their genital glands. Subsequent ablation of the parathyroids in the female dog results in the usual reduction of calcium in the serum.—Joseph Lignières: A new method of immunisation against diseases with filtrable viruses; its application to antiaphthous vaccination.

CRACOW

Polish Academy of Science and Letters, May 2.—K. Dziewoński and M. Brand: The synthesis of ketones, acetyl derivatives of β-methylnaphthalene. By the interaction of acetyl chloride and β-methylnaphthalene in the presence of aluminium chloride, two isomeric ketones were obtained, which were identified. A diketone was also obtained.—W. Friedberg: The Miocene Pectinideæ of Poland and their stratigraphic value.—Mme. N. Natanson-Grodzińska: The plasticity of the instincts in the aquatic larvæ of Cataclysta.—M. Konapacki and K. Ereciński: The rôle of the vitelline sac in the metabolism of the embryos of *Syngnatus acus*.

LENINGRAD

Academy of Sciences (*C.R.*, No. 12, 1931).—P. Schmidt: A collection of flat-fishes from Fusan (Korea). The collection proved to contain twenty-four species, including one new to science, *Arnoglossus wakiayi*, sp. n. Fifteen of the species recorded belong to the Japanese fauna, six are more northern in their distribution, and only two can be considered tropical.—G. Adlerberg: The antelopes of northern Tibet and of neighbouring territories. A key is given to the Tibetan species of the genera *Pantholops*, *Gazella*, and *Procapra*, and notes on each species, with the discussion of geographical variation. *Gazella subgutturosa reginæ* subsp. n. is described from north-west Tsaidam.—I. Starik and A. Gurevitch: The adsorption of radium by glass. Description of experiments demonstrating that radium is adsorbed by glass in a neutral medium, while in an acid medium the adsorption is exceedingly small.

(*C.R.*, No. 13, 1931.)—N. Filipjev: Lepidopterological notes (11). Some forest pests from the Caucasian littoral of the Black Sea. Three species new to the Caucasian fauna are recorded, and one species new to science, *Platyptilia diversicilia*, is described.—V. I. Gusev: Bionomics of two species of Microlepidoptera new to the U.S.S.R., *Evetria fessulatana* Stgr. and *Laspeyresia mariana* Zerny. The first of the two species develops in cones of *Cupressus*, the second in berries of *Juniperus*.—**B. Stegmann**: Origin of the bird fauna of the taiga. Pre-glacial fauna of the southern Siberian taiga was composed mainly of Sino-Himalayan elements, while that of the eastern Siberian taiga showed a very close relation with the fauna of North America.—**A. P. Semenov-Tjan-Shanskii and St. Breuning**: Three new species of the genus *Carabus* from Central Asia. Descriptions of *C. shokalskii* sp. n. and *C. znojkoi* sp. n. from Tjan-Shan, and of *C. redikortzevi* sp. n. from the Alexander range in Turkestan.—**V. V. Barovskii**: Notes on two species of beetles new to the fauna of the U.S.S.R., and description of a little-known species of the genus *Xylobanus* Ch. Waterh.—**S. Bernstein**: An example of a continuous function for which the Lagrange formula of trigonometric interpolation diverges.

(*C.R.*, No. 14, 1931.)—**A. Fersman**: The geochemical arcs of the Chibin Mountains.—**N. Filipjev**: Lepidopterological notes (12). A new *Hypochalcia* from the Ukraine. A description and figures of *Hypochalcia ukrainæ* sp. n.—**A. M. Popov**: *Anarrhichas orientalis* Pall., its systematic position and distribution, with notes on the species of *Anarrhichas* in the U.S.S.R.

SYDNEY

Royal Society of New South Wales, May 4.—**Edwin Cheel**: A review of systematology in botany (Presidential Address). In modern genetical literature, species and their subordinate units are regarded as populations. The units are not easy to define, and, because of this, certain biologists are of the opinion that the main criterion of an individual should be its physiological anatomy. Contrasts were given between the Jordanian methods of splitting the Linnean species into numerous elementary species or micro-species which appeared to be the same as what Lotsy termed ' group hybrids '. It has been found by extensive cultures that certain so-called ' pure lines ' give a much higher percentage of mutation than others. From this result Nilsson draws the conclusion that the original ' pure line ' did not contain only homozygotes, but also some sort of ' segregants ' caused by the heterozygosity, thus upsetting the current theory of the production of pure, namely, homozygotic, lines by autogamous reproduction.

VIENNA

Academy of Sciences, April 28.—**Fritz Rieder and Elisabeth Rona**: Investigations on the ranges of the α-rays of actinium products. With RdAc the two prominent groups of lines with ranges of 4·7 and 4·35 cm., already seen by other workers, are observed. In addition, three other groups with lower intensities and with the ranges 4·6, 4·3, and 4·2 are found. These groups correspond with those recently detected by Curie and Rosenblum in the magnetic spectrum, but the α_1, α_2, and α_3 groups of these authors are not revealed by the author's procedure. The groups with ranges 4·3 and 4·2 were attributed by Curie and Rosenblum to AcX, but the results now obtained indicate with certainty that they belong to RdAc. Experiments with AcX preparations free from RdAc give the known group of range 4·3 cm., and also a second of range 4·1 cm. For AcC the groups with ranges 5·0 and 5·4 cm., observed by Rutherford, Wynn-Williams, and Lewis, are confirmed. With AcA, indications of a fine structure are obtained, since, in addition to the group of 6·47 cm. range, two weak groups with ranges of 6·35 and 6·60 cm. appear to be present. Moreover, with An a group with the range 5·6 cm. occurs, besides that with range 5·70 cm.

Forthcoming Events

Congress

AUG. 31–SEPT. 7

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (YORK MEETING)—continued.

Monday, Sept. 5.

At 10 A.M.—Prof. P. G. H. Boswell: " The Contacts of Geology: the Ice Age and Early Man in Britain " (Presidential Address to Section C).

Prof. Beatrice Edgell: " Current Constructive Theories in Psychology " (Presidential Address to Section J).

Prof. J. H. Priestley: " The Growing Tree " (Presidential Address to Section K).

At 5.30 P.M.—Mr. H. E. Wimperis: " Speed in Flight " (Public Lecture in the Co-operative Hall).

At 8 P.M.—Sir Richard Gregory, Sir Harold B. Hartley, Mr. Donald Gray, Dr. W. W. Vaughan, Prof. W. W. Watts, Mr. W. M. Heller: Discussion on " The Place of Science in the Education of Boys and Girls up to Sixteen Years of Age ".

Tuesday, Sept. 6.

At 8 P.M.—Mr. C. C. Paterson: " Uses of the Photoelectric Cell " (Evening Discourse in the Co-operative Hall).

Official Publications Received

BRITISH

How Electricity helps the Farmer: with Special Reference to Power and Lighting in and around Farm Buildings; Dairy Farming; Poultry House Lighting. A paper presented by F. E. Rowland at the E.D.A. Farmers' Electrical Conference held at the Royal Agricultural Show, Southampton, July 7th, 1932. Pp. 19. Electricity and the Farm. Pp. 12. (London: British Electrical Development Association, Inc.)

City of Leicester Museum and Art Gallery. Twenty-eighth Report to the City Council, 1st April 1931 to 31st March 1932. Pp. 27. (Leicester.)

Technical College, Bradford. Diploma and Special Day Courses, Session 1932-33. Pp. 240+19 plates. (Bradford.)

Journal of the Royal Microscopical Society. Series 3, Vol. 52, Part 2, June. Pp. xvi+113-252. (London.) 10s. net.

Transactions of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne. New Series, Vol. 8. Pp. viii+165. (Newcastle-upon-Tyne.) 3s.

Navy: Hydrographer's Report. Report on Admiralty Surveys for the Year 1931, by the Hydrographer of the Navy. Pp. v-x. (London: Admiralty.)

(University of London): County Councils of Kent and Surrey. The Journal of the South-Eastern Agricultural College, Wye, Kent. No. 30. Edited for the College by Dr. S. Graham Brade-Birks. Pp. 274. (Wye.) 7s.; to Residents in Kent and Surrey, 4s.

Scientific Proceedings of the Royal Dublin Society. Vol. 20 (N.S.), No. 22: The Inhibition of Chemical Reactions. Part 5: The Influence of Pyridine and other Substances on the Absorption of Ethylene by Sulphuric Acid, and on the Surface Tension of Sulphuric Acid. By William Sydney Eagar Hickson and Dr. Kenneth Claude Bailey. Pp. 267-279. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

FOREIGN

Japanese Journal of Astronomy and Geophysics. Transactions and Abstracts, Vol. 9, No. 3. Pp. iii+127-243+13-32. (Tokyo: National Research Council of Japan.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 15, No. 3, May. Pp. 123-201. (Tokyo and Kyoto: Maruzen Co., Ltd.) 1.70 yen.

Annotationes Zoologicae Japonenses. Vol. 13, No. 4, May 5. Pp. 273-439. (Tokyo: Zoological Society of Japan.) 4.00 yen.

Handelingen van het Zesde Nederlandsch-Indisch Natuurwetenschappelijk Congres gehouden te Bandoeng 22, 23, 24, 25, 26 September 1931. Pp. 717. (Bandoeng: A. C. Nix and Co.)

Smithsonian Miscellaneous Collections. Vol. 87, No. 7: Preliminary Classification of Prehistoric Southwestern Basketry. By Gene Weltfish. (Publication 3169.) Pp. 47. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 81, Art. 6: A Newly Discovered West Indian Mollusk Faunula. By Paul Bartsch. (No. 2929.) Pp. 12+3 plates. Vol. 81, Art. 9: New Diptera, or Two-winged Flies from America, Asia and Java, with Additional Notes. By J. M. Aldrich. (No. 2932.) Pp. 28+1 plate. Vol. 81, Art. 11: The Forms of the Common Old World Swallowtail Butterfly (*Papilio machaon*) in North America, with Descriptions of Two new Subspecies. By Austin H. Clark. (No. 2934.) Pp. 15+8 plates. (Washington, D.C.: Government Printing Office.)

Egyptian University: Faculty of Medicine. Publication No. 3: The Third Pandemic of Plague in Egypt; Historical, Statistical and Epidemiological Remarks on the first Thirty-two Years of its Prevalence. By Prof. A. W. Wakil. Pp. vi+169. (Cairo.)

Transactions of the Academy of Science of St. Louis. Vol. 27: The Prairie Horned Lark. By Gayle B. Pickwell. Pp. iv+160+34 plates. (St. Louis.) 2 dollars.