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A Scientific Approach to the Colonial Problem

THE Prime Minister has consented to receive a deputation on Monday next in support of a petition urging that the Government should take the initiative in promoting an inquiry into the fundamental causes of rivalry and unrest among the nations, by inviting all other fully self-governing States or Dominions to combine in setting up expert commissions to ascertain and report upon the basic facts in regard to such questions as access to raw materials and world markets, colonial development and the problem of surplus populations, etc. This proposal for fact-finding commissions is, of course, no novel idea ; but the influential support which the petition has received indicates how rapidly the idea is gaining ground.

Already an inquiry into raw materials has been initiated by the League of Nations with the support of Great Britain, and the League Committee on Raw Materials has now completed its report. This inquiry is a direct outcome of an offer made by the British Government in 1935 and formally renewed in 1936. Even earlier, however, valuable work of this kind had been carried out in respect of problems concerned with the Pacific by the Institute of Pacific Relations, and the scientific study of similar problems affecting European relations was considered by a Conference for the Scientific Study of International Relations held at Copenhagen in June 1931.

While, however, the idea of impartial inquiry into the basic facts as a preliminary to concerted action designed to eliminate causes of friction is steadily gaining ground in public opinion, a good deal of valuable investigation is being quietly carried out by different organizations, the results of which have been published. Reference has been made above to the work of the Institute of Pacific Relations ; and the situation in the Far East is the more regrettable because of the admirable work of the Kyoto and later Conferences.

In Great Britain the Royal Institute of International Affairs has already issued a number of valuable studies and reports such as "Raw Materials and Colonies" and "The Colonial Problem", which are only the latest and most detailed of them. In addition, other organizations are doing invaluable educational work, such as the New Commonwealth Institute, by means of its Information Bulletins, on questions of peaceful change and collective security, which not only prepare a wider circle of the public to accept the idea of the impartial investigation of such matters generally, but also assist materially in the formation of intelligent public opinion upon particular questions.

The League Committee for the Study of the Problem of Raw Materials has held three sessions, and the two sub-committees appointed to study the supply of raw materials and difficulties of purchase and payment have completed reports which are embodied in the final report. On the question of supply, the report indicates that while prohibition and restriction of raw materials might be justified as defensive measures, there are serious objections to their use for exercising pressure on other countries, for the preservation of uneconomic industries or for the maintenance of artificial price levels. It recommends accordingly that these obstacles should be removed as soon as possible and that nations should enter into agreements not to employ them. Similarly the Committee takes the view that countries controlling important quantities of raw materials should not place unreasonable obstacles in the way of those wishing to exploit these resources, and that their legislation should take account of the interdependence of nations as the basis of general welfare.

In common discussions this question of access to raw materials has been closely linked with the colonial question, and the League Committee's report indicates that some modification of the privileged situation which nationals of the mother country in fact enjoy in most colonial territories is desirable. Actual monopolies are rare, but the report clearly indicates the need for further investigation and study. Similarly the sub-committee dealing with obstacles to payment makes various suggestions for reducing existing restrictions on imports and exports by bilateral or multilateral action.

The League Committee's report includes, accordingly, a suggestion to re-examine the International Convention of 1927 for the Abolition of Import and Export Restrictions and Prohibitions, which should implement the resolution recently passed by the International Chamber of Commerce asserting that all countries should, so far as possible, have access to essential foodstuffs and raw materials. Much room is, however, still left for furthern ivestigation and discussion before an adequate and generally acceptable solution of the whole problem can be achieved. The appearance in the meantime of the latest report of the Institute of International Affairs* on the colonial problem is therefore particularly welcome. If its presentation is not all that could be desired—much of the third part, "Investment, Trade and Settlement", could with advantage have been dealt with earlier or incorporated in the appendixes, and the first part, "The International Aspect", should properly have followed the second, "The Colonial Aspect"—it contains much information to clarify thought upon many of the proposals at present being debated, such as the extensions of the 'open-door' policy in colonial territories or the transfer of colonies into Mandated Territories or territories under international administration. The most valuable and significant part of the book is, in fact, the second part, in which the colonial aspect of the problem is considered, and especially the chapters in which the theory and practice of the present status of colonies are reviewed and the importance of common principles of administration is stressed. The vast amount of exact information which it contains is, of course, the chief value of the book, but the task of sifting and selection cannot be pursued without judgment on the main issues. Particularly in this section of the report, the directions in which further inquiry is still called for are clearly indicated.

The dominant impression left on the mind by the survey presented in this part of the book is the immense field for co-operation and investigation which the colonial problem presents. It is seen not merely as a matter of immediate controversy, but rather as a constant problem the cure of which lies in the relations between economic and political aspects. The searching analysis which the study group gives of the way in which the democratic countries themselves are living up to the standards they profess shows no tendency to insist on the merits of British administration as opposed to those of other colonial Powers. In such questions as populations, the relative merits of plantations and native farming, labour policy, health services, education and nutrition, the report indicates the real problems to be faced and the need for research in British territories as elsewhere.

No scientific worker can read these chapters without realizing how large a contribution science itself has to make in providing a solution to these problems and assisting in the foundation of a wise policy. The possibilities for human happiness thus indicated make the present international clamour seem as stupid as it is threatening. Common principles of administration are essential because each of the colonial Powers is subjected to the same sort of criticism, whether from within or from without. Each suffers from the other's mistakes. The universal adoption of certain basic principles of justice towards non-colonial Powers and towards subject races is dictated by common prudence as well as by the more generous ideals of progressive civilization.

The colonial Powers must, in fact, prove to other Powers that their policy is not to exercise monopoly rights for themselves but rather to administer colonial resources in the general interest; and they must also prove to peoples in the Colonies that the protection and the administration they offer is a fair return for the taxation and the other obligations they impose, and is directed to ensure local prosperity. The report, indeed, suggests that in its international aspect the colonial problem is more than a grievance of particular "dissatisfied"

* The Colonial Problem. A Report by a Study Group of Members of the Royal Institute of International Affairs. Pp. xiii+448. (London, New York and Toronto: Oxford University Press, 1937). 21s. net.

nations against particular "satiated" nations: it is a grievance of the whole community of nations against the misuse, wherever it occurs, of colonial sovereignty. All departures from the principle of the 'open door' are an injustice to the international community.

The adoption of common principles of administration would facilitate transfer, but the division of Europe into democratic and authoritarian States complicates the issue greatly. Transference of mandates or colonial sovereignty to States repudiating the League Covenant, and with it the international machinery set up to promote international co-operation and to ensure common standards in the administration of subject peoples, would be an even greater injustice to the international community. There is, in fact, little in the report to hold out hope of meeting the needs of non-colonial Powers in terms of prestige and world power.

Though the difficulties in the way of transfer are clearly displayed, a number of concrete suggestions for meeting the needs of the non-colonial Powers by methods that do not involve transfer are indicated for securing equality of economic opportunity. Moreover, the facts in regard to access to raw materials are set forth in a way which scarcely upholds many of the contentions of the non-colonial Powers. If, for the moment, it is assumed that the correct view of the problem is how to make available the raw materials of industry, the report very effectively disposes of some of these illusions. Of the basic raw materials as defined by Dr. Goebbels himself, France, the United States and Russia produce between them 66 per cent of the world's iron ore; the United States and the United Kingdom 54 per cent of the world's coal; the United States, Russia and Venezuela 81 per cent of the world's oil; the United States, India and China 75 per cent of the world's cotton; Chile, the United States and Canada 49 per cent of the world's copper; and Malaya and the Dutch East Indies produce 83 per cent of the world's rubber.

Accordingly, the basic raw materials, with the exception of rubber, are produced mainly within the boundaries of sovereign States. Rubber alone is mainly a colonial product, but this raw material is open to purchase by all comers on equal terms, and there is no reason why foreign capital should not acquire rubber estates. Equal access is indeed given in enormous colonial areas, although considerable restrictions do exist upon free trade in colonial areas not covered by special treaties. An international agreement to guarantee equal commercial access over a much wider area, in accordance with a former principle of British colonial administration, should therefore do something to remove the feeling of non-colonial Powers that they may be cut off at any moment from access to all colonial supplies.

The problem of access to raw materials, therefore, is not the core of the colonial problem. The present study makes it clear that there is no simple solution and that the matter is one calling for the closest and most careful study. No hasty decisions are likely to be an easy way out of a dynamic but constant problem. The position of the colonial Powers is difficult. Mere transfer of colonial territories to the threatening States would not purchase safety and would be treachery to the colonial peoples and to the world community. The exposition of the facts given by the study group of the Royal Institute of International Affairs reinforces the need for some effective international organization and authority, such as the League of Nations, to which all colonial territories could ultimately be surrendered for administration under trust for the world community. Until that organization and authority are effectively established, the colonial Powers must perforce live dangerously, and their danger is best mitigated if their sovereignty is exercised in trust, first on behalf of the peoples inhabiting these areas and secondly for the wealth of all nations. In their own interests alone they must extirpate all taint of monopoly and exploitation.

Such a policy is not one of mere negation to the demands and aspirations of the dissatisfied or non-colonial Powers. It is essentially one of peaceful change, which offers the maximum inducement to participation in a system of international co-operation and collective security. Only as the facts are impartially assembled, and lucidly presented and clearly understood, can we hope to win acceptance of such ideas or policy, and the greatest merit of this volume is the weighty contribution it offers to the education of public opinion, in Great Britain no less than in other countries. Nor should it be forgotten there will still remain the task of organizing public opinion effectively everywhere to compel action in accordance with the facts, and to resist those nations who wantonly disregard them to the detriment of the community of nations.

World Structure

Relativity Theory of Protons and Electrons
By Sir Arthur Eddington. Pp. viii + 336. (Cambridge: At the University Press, 1936.) 21*s*. net.

DURING the past ten years or a little more, physicists have found themselves more and more peremptorily confronted with a question of theoretical conscience—a question which has gradually and almost inadvertently become of overwhelming weight. It is that of how to reconcile Relativity Theory and Quantum Theory. Increasing uneasiness grew from the fact that in the course of their development, *both* theories approached what many regarded as final states of perfection, but without reaching true *Anschluss* to one another, or even reconciling their mutual discrepancies. Having, both of them, acquired the rank of inalienable knowledge, they seemed incapable of undergoing serious modifications, yet in urgent need of such, in view of the mutual inconsistency of their respective fundamentals. The book under review, which is an enlarged exposition of the author's investigations from 1928 until 1936, in a way is a continuation of his well-known book on relativity. The least that must be said in praise of the present work is that Sir Arthur puts forward sufficient evidence of *blunder* (in the sense of misapprehension, of course) in current quantum- or wave-mechanics to reassure us that, in this theory, there is room and indeed need, for radical readjustment.

The General Theory of Relativity deals with macroscopic space, time and matter, which it treats as continua, admittedly ignoring the particle-structure. Space and time were formerly regarded as the mere frame, scene or stage on which or in which physical events take place. The content of the frame or the actor on the stage was called *matter*. Relativity Theory established such an intimate connexion or rather amalgamation between matter and space-time, that the conceptual separation into a pre-existing continuum and what is contained in it is no longer applicable. Space is extended or unfolded by the very matter it contains, and the rolling on of time is essentially determined by its presence. Though *actio in distans* is definitely excluded, yet the most primitive circumstances of an observation made now and here turn out to be the complicated product of all that has been going on hitherto in the rest of the world.

Quantum Theory, in its turn, has emerged from the careful consideration of observations on the detailed behaviour of the matter surrounding us on our globe and in our epoch—which from the cosmical outlook means in the immediate neighbourhood of a *point* in space-time. By challenging a new meaning for the older ideas of atoms, electrons, radiation, etc., this theory has succeeded in accounting for bewilderingly numerous and complicated facts from comparatively simple (though strange) first principles. It is not very astonishing that in following up these tasks, quantum-physicists deemed it permissible for their purpose to accept as a given thing, which on that occasion called for no further scrutiny, the most primitive condition of the events they investigated, namely, that they happen in space and time; the more so since a rough estimate by Einstein's theory shows that not only the mutual gravitation between the particles composing an atom or a crystal, but also even the modifying influence of a particle on space and time in the *immediate* neighbourhood of the particle is altogether negligible. We were content to pay to Relativity the tribute of conformation to its small-scale geometrical principle, that is, to make everything invariant to the Lorentz transformation (unduly stretching the principle in some cases, as Eddington appropriately points out). But what was neglected was the following. The plane and apparently simple condition of *unmodified* space and time, under which every single particle is observed, is created by the previous and present existence of all the other particles in the world. This fact constitutes an interrelatedness between all of them which makes it imperative to treat previously, in broad outline at least, the problem of the universe, in order to obtain the right outlook for dealing with what is usually, but not very appropriately, called one or a few *isolated* particles.

Having reached this conclusion, we can make two gratifying and promising remarks. First, that quantum theory of its own right is entitled and even compelled to raise the imperative demand of dealing previously with the universe. Secondly, that relativity theory, by its very tendency to ignore the detailed structure of matter and to roam farther and farther to the outskirts of the universe, has quite unexpectedly provided the only sound means for explaining *atomicity*.

To elucidate the first statement: quantum mechanics has to abandon the idea of individuality in different particles of the same kind, two electrons for example. When, let us say, a carbon atom is excited, one of its six electrons is removed to a greater distance from the nucleus; but it is not quite correct to think of an individual electron occupying the special position, the other five forming the inner core. At any rate, if one indulges in that way of viewing the subject, one has to put up with inadvertent *exchanges* between the electron under consideration and one of the others. Now there is nothing, in principle, to preclude the exchange of a particular electron we are contemplating with *any* other electron existing in the world. Hence if we have excluded some of them, or even most of them, from our investigation, we are quite likely to find ourselves all at once contemplating—nothing. This makes it fairly clear that one has to start by investigating the universe as a whole and to derive the methods, if any, for dealing with small isolated systems from the former investigation.

As regards the second remark: it is by discovering the *finiteness of space* that Relativity Theory has inadvertently found the clue to atomicity. The argument runs as follows. Atomicity is merely the oldest, best-known and still most important expression of the inherent *discontinuities* in Nature. Generally speaking, the latter are accounted for in wave- or quantum-mechanics by means of a close analogy with the discontinuous sets of proper modes of vibrating systems. But artificial devices have to be introduced for that purpose, because only a finite system possesses discontinuous proper modes. So the theorist has to segregate a finite portion of matter, keeping it together by strong forces or enclosing it in a 'box', in order to show atomicity appearing in the segregated region. If the universe were infinite it would be hard to explain along these lines why it is constituted of discrete particles, because its proper vibrations would form a continuous sequence. But Einstein's finite universe is in itself the natural and wall-less box, which engenders atomicity by the necessary discreteness of its proper modes of vibration.

All these different considerations converge to state Sir Arthur's main problem, as I see it, in broad lines thus: treat Einstein's closed universe along the lines of wave-mechanics, as you would treat a gas contained in a vessel, and try to make clear at the same time (1) the observed macroscopic features of the universe, (2) its being composed of particles, and (3) why current quantum-mechanics, dealing with isolated systems in the way it does, is able to account for such a vast multitude of facts (in other words, to regularize the customary procedure of quantum-theorists).

For the benefit of physicist readers, let me give a few details. The actual world is tentatively considered to be sufficiently near *that* state for which the name of Einstein universe, properly speaking, is usually reserved, which really is the only static (though unstable!) state that is at all thinkable. It is therefore suggestive to identify it, from the point of view of quantum-mechanics, with the *ground state* of the system (the 'normal' or 'unexcited' state, in the case of an atom). Moreover, as in the case of the atom, the Pauli exclusion principle is admitted for the universe, stating that every energy-level (= proper mode) cannot be occupied by more than *one* particle. This really is the most important step. By it the ground state consists in the N lowest successive energy-levels being occupied each by one particle, whereas all the higher levels are vacant (a so-called completely degenerate Fermi distribution). Rigorously fulfilled, that would correspond to the absolute zero of temperature and make the system completely inert. The *actual* state is assumed to be one of slight excitation, very near to the ground state, with just a slight stirring up of the particles at the limit or threshold between the close-packed Fermi distribution below and the ordinarily vacant levels above. (From the point of view of wave-mechanics the levels are the proper vibrations of entire space. They are pictured as three-dimensional spherical harmonics, which by their nodal surfaces subdivide space into compartments of decreasing size. With the lowest mode entire space forms one compartment only. At the limit the compartments turn out to be about the size of a pint.)

It is, of course, the stirred-up threshold region between ordinarily occupied and ordinarily vacant levels which gives rise to the observable events (as in the atom the radiation is produced by the stirred-up light-electron). The particles *we handle* have emerged from this region and must, therefore, possess a certain minimum of energy—that of the threshold level—which is obviously their *proper energy*, m_0c^2, embodied in their rest-mass m_0. (My account cannot avoid being *very* rough—as though there were only *one* sort of particles in the world!) On the other hand, the totality of occupied levels (= vibrating modes) constitutes the mass of the universe and determines its radius R—by a well-known formula of General Relativity.

This enables one to *calculate* the radius R of space and the total amount of matter (or number N of particles) it contains from such physical constants only as can be determined within the walls of a room without windows. The results are in excellent agreement with astronomical evidence from, mainly, the recession of extragalactic nebulæ—thereby corroborating the opinion that the conditions prevailing in our laboratory experiments are *essentially* determined by the state of the universe as a whole.

The particles well below the threshold have, each of them, an energy *smaller* than the observed rest-energy m_0c^2. The *energy-defect* (as it were) corresponds, in the author's opinion, to what in Newton's theory appeared as the *negative potential energy* of gravitating matter. Again, the entire lot of sub-threshold particles or levels supersede the cumbersome lot which in Dirac's famous 'hole'-theory of the positron appeared as an infinite continuous sequence of ordinarily occupied levels of negative energy ; and there is the great advantage over the latter that (1) the sub-threshold levels form a *discontinuous* lot, as particles ought to, (2) they are numerous (of the order of 10^{79}) but not infinite in number, (3) they constitute the bulk of the material of the world, whereas Dirac's lot were mere dummies, place-keepers, doomed otherwise to inactivity.

I have to refrain from following up many other ideas, however interesting they may be. I should be astonished if they proved all tenable in the form given, and so would Sir Arthur be, I believe. We have here before us a sketch of unusual grandeur, of which not the details alone need further development and, maybe, much modification. I am convinced that, for a long time to come, the most important research in physical theory will follow closely the lines of thought inaugurated by Sir Arthur Eddington.

E. SCHRÖDINGER.

The European Snake Venoms

Die europäischen und mediterranen Ottern und ihre Gifte:
Grundlagen zur Darstellung eines wirksamen Schlangenserums. Von Prof. Dr. Richard Bieling, Dr. Albert Demnitz, Dr. Otto Schaumann, Prof. Dr. Hans Schlossberger, Dr. Waldemar v. Schuckmann, Dr. Ernst Schwarz. (Behringwerk-Mitteilungen, begründet von E. v. Behring, Heft 7.) Pp. x + 362 (35 plates.) (Marburg-Lahn: Selbstverlag der Behringwerke, 1936.) n.p.

THE idea for this work originated with Dr. Richard Bieling, head of the Serological Department of the German Dye Trust at the Behring Works, Marburg, and it is due to this organization and its financial assistance that it has been possible to carry it through. The work was commenced in 1931 in an endeavour to find a better and more reliable antivenine for the European vipers in general.

The volume is divided into five parts, and each one is provided with a complete bibliography of its own.

Part 1, by Dr. Schlossberger, is an excellent and careful review of the history of snake venoms in general, and of the methods adopted through the ages for combating it. Part 2 discusses the pharmacology and chemistry of snake venoms and snake sera, and reviews the different groups, neurotoxic, hæmolytic, etc., into which the snake venoms can be divided. Part 3, by Dr. von Schuckmann, deals with the ecology of the European vipers, the methods of keeping and transporting them, a brief account of the venom apparatus, the moulting processes, hibernation, the treatment of disease, and finally the technique of extracting and preparing the venom for use in the making of antivenine. Part 4, by Drs. Schlossberger, Bieling and Demnitz, discusses the question of antivenine in general and the manufacture of an antivenine for the European vipers in particular. This is the most important part of the book, and it contains much information that is both new and interesting.

The venoms of all the common species of European vipers were examined and their actions observed by experiments on mice. It was found that, not only did the venom of each species and subspecies differ as regards its properties and action, but also that the venom of the same species might vary when taken from specimens obtained in different localities. As was to be expected, the venoms of the majority of the European vipers were hæmolytic and coagulent in their action, but *V. berus bosniensis* and, to a lesser extent, *V. a. ammodytes* and *V. u. ursinii* differed in having high neurotoxic properties.

In addition, the antivenines marketed by the different institutions throughout the world were obtained, and their efficacy tested against the venoms of the well-known poisonous snakes, both colubrine and viperine. The results obtained from all the experiments are graphically summed up in a series of charts.

Dr. Schwarz concludes the work with a review of the systematic position of the European members of the genus. Four species are recognized, each with their several subspecies. They fall naturally into two groups, *V. berus*, *V. ammodytes*, and *V. ursini*, the true European species, in one section, *V. lebetina*, an entrant into Europe from Asia, in the other. Their evolution is discussed, the distribution of each form is given and is shown on a large-scale map, and the means by which dispersal was effected is suggested. This part of the work is lavishly illustrated with plates. Each form is figured at least once, and the colour-plates are excellent.

M. A. S.

Progress of Biochemistry

Annual Review of Biochemistry

Edited by James Murray Luck. Vol. 6. Pp. ix + 708. (Stanford University P.O., Calif.: Annual Review of Biochemistry, Ltd.; London: H. K. Lewis and Co., Ltd., 1937.) 5 dollars.

DR. J. M. LUCK and his associates produced the "Annual Review of Biochemistry" for 1937 in ample time for the commencement of the new academic term, when research workers and advanced students, refreshed by their vacation, are eager to achieve new conquests in this field. The present rate of progress is amazing—10,000 papers were abstracted in the previous year—though it is quality alone which matters and one could wish for an etiquette among workers which forbade publication until substantial achievement could be reported. Unfortunately, to-day in the hustle for priority the reverse happens and far too much immature work is published.

We find the quality of the reviews themselves to be improving; they enable the reader to take a definite point of view instead of being a mere recital of results.

With so much available for comment, the reviewer is embarrassed in his choice. First mention may, perhaps, be made of two articles of a timely nature—a sound policy of the editor. One of these deals with the biochemistry of fish: the other with the application of microchemistry to biochemical analysis, entrusted to C. M. McKay of Ithaca, N.Y., and P. L. Kirk of Berkeley, California, respectively.

Fish have hitherto been rather neglected by the chemist, but their culture on the large scale for culinary and stream-stocking purposes has made it more easy to experiment with them—in the United States there are seven hundred fish hatcheries. There is a great species difference among fish, and the trout, most widely studied, conduct their life processes at very low temperatures. A systematic study of growth and physiological problems connected with fish is now under way, and with so much material available and experimentation relatively easy, very definite results may be expected to accrue.

Every major problem of the chemist has been furthered by the use of micromethods: in fact without such the science to-day would be nothing like so far advanced. The name of Fritz Pregl of Graz, who started the development, must stand high on the roll of honour.

In all, the volume contains 28 reviews by 35 authors, the subjects being classified as is now customary. There is a certain amount of overlapping or duplication with substances which come under two headings, but this is all to the good at the present time. An example is afforded by the co-ferments now described as phosphopyridine nucleotides, the nature of which has been at last worked out—their discovery by Sir Arthur Harden thirty odd years ago in connexion with cell-free fermentation aroused a lot of interest. They consist of a pyridine derivative, namely, nicotine acid amide, adenine, two molecules of a sugar, ribose, together with two or three molecules of phosphoric acid, according to their origin. Warburg and a number of other workers have been active in this field.

An attractive review by R. Schoenheimer and E. A. Evans of Columbia treats the chemistry of the steroids, a new term proposed for compounds related to cholesterol to include the sterols proper, the bile acids, cardiac aglycones, toad poisons, saponins, and sex hormones; these form as diverse and remarkable a group of natural substances as can well be imagined, and it is a great achievement largely to have cleared up their problems. Progress has been rapid this last three years since the revision of the old formulæ; the group is uniquely characterized by dehydrogenation with selenium to aromatic hydrocarbons in which the original cyclic carbon skeleton is intact.

Another biochemical field which is assuming increasing importance is that of sulphur compounds, reviewed by V. du Vigneaud and H. M. Dyer of Washington. Biological material has now yielded glutathione, methionine, ergothionine, vitamin B, djenkolic acid, asterubin and heparin, to which must be added a new adrenal compound, $C_4H_{10}O_3S$, the constitution of which has been confirmed by synthesis. Much interest attaches also to the chemical behaviour of the sulphur of proteins.

It would be easy to extract examples of marked progress from every review but space restricts us to final mention of the carotenoid pigments, of which a considerable number of new ones have been isolated from land and water plants largely as the result of the ease of isolation, purification and identification which the newer methods of adsorption, absorption and microchemical analysis have brought. There can be no active biochemist who can afford not to keep this book on his desk.

E. F. A.

The Right Hon. Lord Rutherford of Nelson, O.M., F.R.S.

ERNEST RUTHERFORD was born in New Zealand on August 30, 1871, and he was well educated at schools in Brightwater and Nelson, where his headmaster was the famous cricketer W. J. Ford, formerly a classical master at Marlborough. Rutherford went with a scholarship to Canterbury College, Christchurch, where he quickly made his mark by carrying out an interesting and important research with a magnetic detector of wireless waves. There is a striking similarity between Rutherford's work and that of the famous American physicist, Henry. Both used an aerial, a coil of many turns round a bundle of fine sewing needles and a small magnet which was deflected by the changed magnetism of the needles due to the current in the aerial produced by the wireless waves. Henry, however, detected lightning flashes up to ten miles' distance; Rutherford the sparks from an induction coil, two miles away. I once asked Rutherford if he had then already heard of Henry's work, and he replied, "No"! The two minds converged independently. The genius of Marconi afterwards developed an important magnetic detector which, before the age of valves, was in common use for wireless detection in ships.

The Commissioners of the 1851 Exhibition made a good choice when they elected Rutherford as a scholar. Indeed, has any money ever been better invested? This award enabled Rutherford to go to the Cavendish Laboratory at Cambridge, where Sir J. J. Thomson was conducting his own famous researches and guiding the first great group in England of young physicists, including such men as C. T. R. Wilson, Townsend, H. A. Wilson and Rutherford.

It was at that time a novelty for a young physicist to arrive at the Cavendish from near the antipodes, and there was a slight tendency to ridicule. However, formidable questions from the new arrival were received with some awe, and the rumour soon spread that there was "a young rabbit come from New Zealand, who burrows very deep".

The Cavendish group were at this time measuring the properties of electrons and ions, and in particular there was an interesting method of Rutherford's whereby ultra-violet light shining on a metal plate released electrons, which were made to leap up and down in cycloidal paths by a controlled intensity of alternating potential.

In the meantime the first research professor, the brilliant Hugh L. Callendar, had left McGill for the Imperial College and so the director of the Macdonald Physics Laboratory, John Cox, visited England (1898) and was so wise and so fortunate as to secure Rutherford as successor to Callendar.

Rutherford even then had a very intimate knowledge of ions, whether produced by ultraviolet light or X-rays. In fact he once remarked, "Ions are such jolly little beggars, you can almost see them." He was therefore able to pursue with swiftness and accuracy his investigation of the radiations from radioactive substances which had been discovered by the genius of Becquerel, Pierre and Marie Curie, and others. Moreover, Sir William Macdonald presented his laboratory with a liquid-air machine, and three hundred dollars (£60) with which were bought 60 milligrams of radium at cost price from Giesel, who scorned to make a profit from a colleague.

In the Department of Chemistry at McGill University, there was a young Oxford physical chemist who joined Rutherford in the investigation of the relation between thorium and thorium X, obtaining results somewhat similar to those of Sir William Crookes with uranium and uranium X. They, Rutherford and Soddy, were able to put forth a most bold and startling theory, which was received at first with scepticism and opposition. Indeed, Lord Kelvin died in unbelief of this great principle, which has now stood the test of time and multitudinous experiments. Atoms were no longer to be regarded as permanent, everlasting and indivisible. Radioactive elements disintegrated spontaneously; they broke up by 'chance', independently of their age or their physical surroundings, or their chemical combinations. The mortality rate was constant for one species, but varied from one type of atom to another. In each case the disintegration took place by internal energy with the projection of an alpha particle (He^{++}) or of an electron (beta ray) and the residual atom was of a new type different from its parent atom. This theory was rapidly developed and applied skilfully to radium, its emanation (radon) and three successive products with the prosaic but useful terminology—radium A, B and C. Rutherford was asked to give the Bakerian Lecture to the Royal Society (1904) and was awarded in consequence the Rumford Medal, and he soon published his first book (1906), entitled "Radioactivity", written with a breathless enthusiasm.

Rutherford's direct advance along the royal road of physics—for he seldom wandered into byways and blind alleys—deterred him from adventures in mathematical physics. Yet he never seemed to lack the necessary mathematical equipment essential for the interpretation and calculations of his work. Witness the masterly use of exponentials in his Bakerian Lecture, where nothing to-day need be altered or removed. The whole scheme of such calculations, transformations and graphs is familiar enough now to physicists, but it was all new near the beginning of the century.

In 1903, Rutherford had worked out the short-period group of the radium family, but he was faced with really puzzling properties of the long-period group, which necessarily involved observations extending over months. He had, however, 'grown' from radon, and he had detected and isolated, by most ingenious methods, both radio-tellurium (now radium E) and the first radioactive substance found by Mme. Curie—polonium (radium F). These atoms were in the direct line of descent of the radium family, but there was a gap! Radium C did not turn directly into radium E; there was some intermediate body the radiations from which Rutherford was at that time unable to detect. He therefore postulated a 'rayless' change of long period, ten or twenty years, and called the substance radium D, sometimes now called radio-lead, which really ejects beta rays, thoroughly investigated by many workers. But, at the time, this bold prediction of the existence of a material substance, of which no single physical property was known, beyond the fact that there should be an inevitable successor to C, and a forerunner to E, struck me as most remarkable, and on recalling, thirty years later, these circumstances to Rutherford, he was himself impressed. Men may well believe in an undetectable æther, because of its known physical properties, but here was belief in a substance without any properties except that of a go-between!

A great part of the scientific life of Rutherford was spent in his investigation of the properties of alpha particles, and the wisdom of this choice has been abundantly justified by a series of successes. He deflected alpha particles with a magnetic field, and proved that they carried a positive electric charge. He then deflected them to a measured extent both in magnetic and electrostatic fields and thus found both the velocities and the ratio of mass to charge of alpha particles. The inference was that an alpha particle had a mass four times that of a hydrogen atom, and a double positive, electronic charge. This result suggested helium, and the presence of that gas in pitchblende and thorianite was evidence in the same direction. In 1904 Ramsay and Soddy definitely obtained the helium spectrum from aged radon, and five years later Rutherford and Royds collected the alpha particles, ejected from radon, after their passage through the exceedingly thin walls of a glass container, and again verified the nature of their catch with the spectrum obtained. To forestall a little, it may be pointed out here that Rutherford also used alpha particles in the scattering experiments which proved the existence in the atom of the minute massive nucleus with its positive electrical charge; and yet again in his most remarkable experiments on the artificial disintegration of nitrogen, etc., and on the transmutation of matter, it was alpha particles which he employed as his directed agents.

In the meantime, Rutherford was building up a school of research physicists in his laboratory at McGill. For example, he suggested to H. L. Cooke that because there was radium in the ground, there must be some penetrating radiation (gamma rays) coming upwards from the earth. At first Cooke was not successful in finding what was wanted, but Rutherford persisted: "Try more lead!" There followed a toilsome experiment with very much lead, and finally Cooke not only proved the existence of a penetrating radiation, but also he was astute enough to show that the radiation came from all directions, even from above. This was attributed at the time as coming from the bricks of the wall, etc., but he may have been unconsciously screening his electroscope from cosmic rays!

The arrival of Otto Hahn at McGill was a noteworthy event. He had been working with Ramsay, who had given him some thorianite with the object of extracting some *radium* from that ore, using Mme. Curie's method of fractional crystallization. To the surprise of both Ramsay and Hahn, the residue became more and more powerfully radioactive, while the production of radium was small. The concentration of the residues led to the discovery of a material many thousands of times more radioactive, weight for weight, than the parent thorium. This was an experience similar to that of Mme. Curie when she extracted radium from uraninite. The question was: What was the nature and position of this new substance which Hahn had discovered? He came to Rutherford at McGill to find out. Now on arrival Hahn was naturally excited and enthusiastic, and his English at that time was not altogether adequate, so that at first Rutherford seemed somewhat puzzled and sceptical, but when Hahn showed him the presence of the emanation of thorium (thoron), with a period of 53 seconds, Rutherford was enthusiastic over this discovery of *radiothorium*, an important and powerful member of the thorium family, which decays to half-value in 1·9 years. Hahn continued to work with Rutherford at McGill for a year or so, discovering radioactinium, and carrying out further investigations of the thorium family, which he has continued with brilliancy in Berlin, and which have justly brought him fame.

Godlewski—a clever and charming Pole—came from Lemberg to work with Rutherford at McGill. We were trying, without much hope, to deflect the gamma rays of radium in a very powerful magnetic field. As expected, it was a null experiment, but Godlewski thought that there might be a better chance with the softer rays of actinium. One morning he showed me his photographic plate with two distinct lines half an inch long, branching like the two horns of an antelope. He had used a magnetic field and reversed it. Again he was dancing with joy and greeted Rutherford: "I have completely deflected the gamma rays of actinium." Rutherford glanced at the plate. "Do it again," he said with a smile. "Certainly, I will do it at once," replied Godlewski; but he tried week after week without a shadow of success, and it may well be wondered what malignant sprite had placed that flaw in just the very place to delude the enthusiastic Godlewski. Alas! he, a physical chemist, died in Lemberg the victim of a slow and undetected escape of gas containing carbon monoxide.

Rutherford and Barnes measured with fair accuracy the heating effect of radium and its products, assigning the proportions between the three types of radiation. Such measurements, in combination with Lord Rayleigh's determinations of the amount of radium in various primary and sedimentary rocks, have settled the long drawn-out controversy between Kelvin and Huxley as to the age of the earth. Indeed there is now an embarrassment of riches, for there is more than sufficient radium in the earth to prevent its cooling, so that, as Rutherford said, the geologist can fill up a blank cheque as he will, and can postulate successive heatings and coolings such as the series of ice ages, and mountain building, and volcanic activity seem to require. Moreover, the amount of lead (radium G), or of helium, accumulated in radioactive ore bodies of various ages affords a useful measure of geological time. Thus it is possible to point to a piece of pitchblende (it may be), and to state with some precision that the specimen has existed in its present compacted form for a period of 700 million years, and it is further possible to give a higher limit (2×10^9 years?) to the 'age' of the earth.

When Dewar discovered the selective absorption of various gases by coco-nut charcoal, he laid the foundation of the modern gas mask. (To Dewar, too, we owe the boon of the thermos flask.) Rutherford checked the selective absorption of radon and thoron and actinon by charcoal, and told me to measure the amount of radium emanation in the atmosphere, which was in due course completed. Note Rutherford's love of measurement, as a chief essential in physics. He took a lively interest, too, in the scattered or secondary radiations in matter, due to the beta and gamma rays of radium, but after a few months' work by me, suggested that there was not much more to be made of it! Yet this subject has been pursued ever since, culminating in the discovery of the Compton effect, which indicates that a photon ($h\nu$) can collide with an electron, an idea which would have been considered improbable or impossible in earlier times.

Rutherford later showed much interest and gave his powerful assistance in the development of the treatment of cancer by the gamma rays from five grams of radium in the Radium Beam Therapy Research, and he was a strong advocate of a National Radiological Institute, where the great advances in physics could be furthered and made available to physicians and surgeons for the alleviation of the sufferings of mankind. Such a step would be a fitting memorial to him.

It will be noted that Rutherford gave away freely quite important researches—indeed, he gave far more than he retained for himself. Whether at Montreal, Manchester or Cambridge, he not only made discoveries himself, but also at each place he was the centre of a galaxy of workers who became remarkably prolific both in the quantity and quality of their discoveries. In common with many others, I am deeply grateful for staunch help and unruffled kindness extending over more than a third of a century.

Here was a man of the greatest intellectual power, who has altered the whole viewpoint of science, who accomplished an amazing amount of work of the first order, a physicist who obtained the highest prizes in life, who ranks among the greatest scientific men of all ages; well, it is pleasing to remember that he enjoyed life to the full. True, the sudden death in 1930 of his only child Eileen, wife of Prof. R. H. Fowler, was indeed a staggering blow, only in part relieved by his great affection for his four grandchildren.

Much as we deplore the death of Rutherford while still at the peak of his powers, much as we anticipated a rich harvest from the recent improved facilities at the Cavendish, much as we miss and shall continue to miss his crystal-clear expositions and yet more his friendly and delightful personality, yet who would wish to have seen that bright intelligence wane or gradually fade? He was always a charming blend of boy, man and genius, and it may still be true that those whom the gods love die young.

A. S. Eve.

It was in 1909 that I first came into contact with Rutherford, in my second year in the honours school in Manchester. Owing to some changes in the staff, Rutherford took over a course of lectures on electromagnetism. This was a stimulating experience, for Rutherford was interested in the subject and his account of his own early work remains with me a vivid memory. In our third year some of us were drafted into research work—into the firing line as he would put it—to our great joy and, on occasions, alarm and terror. At that time his main line of work was the study of the properties of the α-particle, already begun in Montreal and continued with increased vigour in Manchester. The counting of the α-particles and the measurement of their charge (both with Geiger) gave a value for the unit of charge which was accepted for some years and showed that the α-particle should be a helium atom. The direct proof followed in the beautiful experiment with Royds. At the same time, the phenomena accompanying the passage of the particles through matter were investigated—the ionization, the ranges of the particles from the different radioactive bodies, the change of velocity and the scattering of the particles.

These latter experiments, carried out by Geiger and Marsden, proved to be of special importance, for they led Rutherford to his conception of the atom as a heavy, positively charged nucleus surrounded by a cloud of electrons in appropriate number. I remember well the occasion on which this idea was first put forward. It was at a meeting of the Manchester Literary and Philosophical Society, to which all workers in the laboratory were invited. Rutherford's account of his theory, backed by Geiger with a description of some new experimental evidence, created a profound impression.

The nuclear theory was the culmination of Rutherford's work on the α-rays, and the finest of all his great contributions to physics. It is scarcely necessary to say that it is the foundation on which all the subsequent developments of atomic physics have been built. The history of this discovery shows very clearly one of the most typical aspects of Rutherford's genius—his extraordinary gift for seizing on the vital point. The discrepancy between Geiger's measurements of the scattering of α-particles through small angles and the apparently trivial observation that a small fraction of the particles which fell on a thin foil were scattered backwards led him straight to the goal. These simple experiments were sufficient to give him the general picture of atomic structure, though further work was necessary to fill in the details. A complete proof of the theory was given some time later by Geiger and Marsden in a series of magnificent experiments, which also showed that the atomic nucleus was of very small dimensions, and gave (roughly) the size of its charge.

The full implications of the nuclear theory were only gradually appreciated. There followed van den Brock's suggestion that the charge on the atomic nucleus was determined by the atomic number, established in Rutherford's laboratory by the famous experiments of Moseley on the X-ray spectra of the elements. The story of Bohr's visit and his development of the nuclear atom to explain spectroscopic series and atomic phenomena is so well known that it needs no repetition here, although this development now covers the whole field of atomic physics. There was further the application by Russell in Manchester, and elsewhere at the same time by Soddy and by Fajans, to explain the chemical properties of the radio-elements.

Meanwhile, Rutherford, continuing work on the α-rays, also began to turn his attention to the β- and γ-rays. With Andrade, he obtained for the first time a spectrum of the γ-rays by diffraction from a crystal; while, with Robinson, he investigated in great detail the line spectrum of β-rays and also showed the connexion between the γ-rays and the β-ray lines, a connexion which in later years has been used with great effect in the study of both β- and γ-ray spectra.

These years, 1907–14, were perhaps Rutherford's greatest period. A stream of papers on all aspects of radioactivity poured from his laboratory, nearly all of outstanding importance. There would be generally about twenty or so workers, including the staff of the laboratory, who in spite of heavy teaching duties yet found time for research. A large proportion of the workers were visitors, for he attracted men from many countries. It seems invidious to mention any names when it is impossible to give all, but as I have already transgressed perhaps I may be forgiven for adding those of Boltwood (a great friend of Rutherford's), von Hevesy, Fajans, Gray, Boyle, Kovarik, Darwin, Russ, Makower, Evans and Florance. And I am sure Rutherford himself would have wished me to add again the name of Geiger, who collaborated in so much of his work and who helped him in many different ways.

The period of the Great War was, of course, relatively unproductive; but in the intervals snatched from other activities, Rutherford pursued his course. He was now speculating about the structure of the nucleus, and when I returned to the laboratory at the beginning of 1919, he had just succeeded in showing that the nucleus of nitrogen could be disintegrated by bombardment with an α-particle. This was a discovery second only to his nuclear theory and the transformation theory, but its great importance was not fully recognized at the time, probably because it remained an isolated fact for some years. With this experiment, however, he opened up a new field of inquiry, nuclear physics, in which there is now such great activity.

In 1919, Rutherford succeeded J. J. Thomson as Cavendish professor of experimental physics in Cambridge. He left Manchester with many regrets, for he had been very happy there and he had made many friends both in the laboratory and outside it. He began in Cambridge to pursue with characteristic energy the paths marked out by his work in Manchester. It was at this time that I came to know him well, for he invited me to join him in continuing the experiments on the artificial disintegration of elements by α-particles. He had long had a special love for the α-particle, but now the nucleus also was admitted to the same intimacy, and the experiments bearing on nuclear structure were his main interest. After the first rapid advances, progress became rather slow, owing to difficulties inherent in the method of experiment. But Rutherford never lost his faith in the ultimate success of this work. The development of electrical methods of counting particles enabled many striking advances to be made, elsewhere as well as in the Cavendish, and the subject of nuclear physics began to open up rapidly.

The real reward for his efforts to develop this field of work came in the spring of 1932, first with the discovery of the neutron, a particle the properties of which he had anticipated several years before and for which he, and I, and others in the laboratory, had previously searched in vain, and shortly afterwards with Cockcroft and Walton's disintegration of elements by protons—disintegration for the first time by means under human control. I mention these two discoveries particularly, not only because of their special significance but also because they are the fruit of his policy and direction. If they do not bear his name, these discoveries bear the stamp of his laboratory, and his delight in them was as great as if he had made them himself.

Many advances of almost equal importance were made during this period 1919–37, so many that it is impossible to mention them one by one. The number of men who took part in these advances is so large that a list of only the most notable names would be inordinately long. The reputation of the Cavendish Laboratory won under Maxwell, Rayleigh and J. J. Thomson was maintained and even increased. The laboratory itself spread in size and received, as an independent satellite, the Royal Society Mond Laboratory under Kapitza.

I have said that the Manchester days were Rutherford's greatest period. This is true so far as his own direct contributions to physics are concerned, but it is not true in other ways. In Manchester his research students were mostly senior men who had already won a reputation. In Cambridge conditions were different. There were, of course, a number of senior workers, but the young men with little or no previous training far outnumbered them. Rutherford recognized very clearly that the training of such large numbers of students would hamper the progress of his own work, but he accepted it as his duty. He gave the most careful thought to the problems on which he put his students, so that these should begin within their powers and lead to a well-marked and profitable line of research. He kept his eye on every man, expecting and at times demanding the best the man could do, and inspiring him with his own enthusiasm. When the time for publication came he read the paper with the greatest care, often making what changes in presentation he thought desirable, even to the extent of re-writing whole sections. No paper left the laboratory until he was satisfied. It would be difficult to overestimate his services and his influence in these directions, for there can be few if any universities in the British Empire which do not contain at least one of Rutherford's students. He came to regard the training of students in methods of research as of almost equal importance to the advancement of knowledge.

Even the casual reader of Rutherford's papers must be deeply impressed by his power in experiment. One experiment after the other is so directly conceived, so clean and so convincing as to produce a feeling almost of awe, and they come in such profusion that one marvels that one man could do so much. He had, of course, a volcanic energy and an intense enthusiasm—his most obvious characteristic—and an immense capacity for work. A 'clever' man with these advantages can produce notable work, but he would not be a Rutherford. Rutherford had no cleverness—just greatness. He had the most astonishing insight into physical processes, and in a few remarks he would illuminate a whole subject. There is a stock phrase—"to throw light on a subject". This is exactly what Rutherford did. To work with him was a continual joy and wonder. He seemed to know the answer before the experiment was made, and was ready to push on with irresistible urge to the next. He was indeed a pioneer—a word he often used—at his best in exploring an unknown country, pointing out the really important features and leaving the rest for others to survey at leisure. He was, in my opinion, the greatest experimental physicist since Faraday.

I cannot end this tribute to Rutherford without some words about his personal qualities. He knew his worth but he was and remained, amidst his many honours, innately modest. Pomposity and humbug he disliked, and he himself never presumed on his reputation or position. He treated his students, even the most junior, as brother workers in the same field—and when necessary spoke to them 'like a father'. These virtues, with his large, generous nature and his robust common sense, endeared him to all his students. All over the world workers in radioactivity, nuclear physics and allied subjects regarded Rutherford as the great authority and paid him tribute of high admiration; but we, his students, bore him also a very deep affection. The world mourns the death of a great scientist, but we have lost our friend, our counsellor, our staff and our leader.

J. CHADWICK.

I HAVE been asked by the Editor to give a brief account of my personal recollections of the late Lord Rutherford. I met him first in October 1895, when a regulation had just come into force by which graduates of other universities were admitted to Cambridge as 'research students', and after two years residence were eligible for the B.A. degree. Rutherford was the first student to apply; he was succeeded in an hour or so by J. S. Townsend, who has since become Wykeham professor of physics at Oxford, so that the first two research students became professor of physics at Cambridge and Oxford respectively. Rutherford when in New Zealand had invented a magnetic detector of wireless waves and his first work in the Cavendish Laboratory was to try to improve its sensitiveness. He showed even at this early stage that he possessed exceptional 'driving' power and ability as an organizer. To test his detector, it was necessary to take observations simultaneously at two places, and the transport of the instrument required organization. He surmounted these difficulties by getting assistance from his friends, and at one time held the record for long-distance wireless in England, having observed at the Laboratory signals which came from the Observatory about two miles away. He had not worked for more than a very few weeks before I became convinced that he was a student of quite exceptional ability.

Whilst Rutherford was engaged with this research, Röntgen rays were discovered and we had found at the Laboratory that when these passed through a gas they made it conduct electricity even with the smallest electric forces. For ten years experiments on the passage of electricity through gases had been going on in the Laboratory; these were excessively difficult as the only ways of getting the electricity to pass through the gas were to use large electric forces and so get sparks, or make the gas so hot that you got flames. Both these were exceedingly capricious in their behaviour. The Röntgen rays gave a very simple and reliable means of making the gas conduct electricity even under the smallest forces, put researches on gases on quite a different footing and promised to add greatly to our knowledge of the subject. Rutherford devised very ingenious methods for measuring various fundamental quantities connected with this subject, and obtained very valuable results which helped to make the subject metrical, whereas before it had been only descriptive.

Yet another fundamental discovery was made while Rutherford was working in the Laboratory, that of radioactivity, which in one form or another occupied his attention for more than twenty years. Henri Becquerel found in 1896 that salts of uranium gave out radiation which, like Röntgen rays, could penetrate opaque bodies and affect a photographic plate. The radiation was not all of one type: one part of it was very easily absorbed; another part could penetrate much greater distances and was defected by magnetic force in the same direction as a negatively electrified body, and a third, present only in small quantities, seemed even more penetrating than the second. In 1918 Rutherford made a careful study of these types of radiation, which he called α, β, γ, a notation which is now universally used; he did not find any irregularities, and commenced a study of the radiation from thorium. He had not completed this when he was elected to the professorship of physics in Montreal in succession to H. L. Callendar, who was also a Trinity man and who had worked in the Cavendish Laboratory with remarkable success.

Rutherford had not been long enough in Cambridge to entitle him to be able to sit for a fellowship when he was elected to the professorship and left Cambridge for Montreal. When he got there, he resumed the experiments on the thorium radiation. These, until the clue was found, were terribly perplexing; what seemed a trivial thing such as a puff of air would produce a great difference in the radiation, while large changes in temperature produced no effect. The thorium seemed to infect bodies placed near it and make them radioactive; they recover after a time if the thorium is taken away. These anomalies, though troublesome, were really a blessing in disguise, for in his attempt to account for them, Rutherford arrived at the view about the processes going on in radioactive substances which is now universally accepted. His view was that the thorium, besides giving out radiations, gives out a radioactive gas which he called an emanation. This may be wafted about, or settle on solids and make them appear to be radioactive. The emanation is not permanent, but after a few hours changes into non-radioactive substance.

Rutherford's scientific activity was never greater than when he was at Montreal. In the years between coming to Cambridge and leaving Montrea to be professor of physics at the Univeristy of Manchester, he had published between forty and fifty papers ; a few of these were joint papers, but the great majority were about researches of his own which had led to results of first-rate importance and which could not have been obtained by anyone who was not an experimentalist of the very first order. In those days, laboratories had no funds to buy instruments as sensitive as those which are now available, and to detect small effects required exceptional skill, patience and self-criticism.

After Rutherford went to Manchester, I did not see much of him until 1915, when Mr. Arthur Balfour, as he was then, created the Board of Invention and Research for the co-ordination and encouragement of scientific effort in connexion with the Great War. Lord Fisher was the president of the Board, and I was a member of the Central Committee. The most pressing need at the moment was some means of detecting submarines. We got Rutherford to draw up a report on the methods which had been used or suggested for this purpose. He reported strongly in favour of a particular method, and we were fortunate enough to secure the services of Prof. W. H. (now Sir William) Bragg as director of a research for this purpose, and provided him with a laboratory and staff Rutherford also visited the United States to find out what they were doing in this matter and to tell them what we were doing. His help was continually being asked on a great variety of questions and there was no one whose opinion carried greater weight.

The Cavendish Laboratory has made great progress under his direction ; the Mond Laboratory for magnetic research and the High-Tension Laboratory have been created. When he came, the supply of instruments for research was too scanty ; it is now in this respect one of the best equipped physical laboratories in existence. Lord Rutherford's activities were very wide-spread ; he was professor of natural philosophy at the Royal Institution, and also held with conspicuous success the very responsible post of chairman of the Advisory Council of the Department of Scientific and Industrial Research. That he could discharge so many duties was due to his powers of organization and that his claim to know a good man when he saw him was amply justified by results. With this faculty he could delegate some of his work to others without injury to the efficiency of the Laboratory, and get time to spare for his other activities. His death just on the eve of his having in the High-Tension Laboratory means of research far more powerful than those with which he had already obtained results of profound importance is, I think, one of the greatest tragedies in the history of science. J. J. THOMSON.

THE splendour of Rutherford's contributions to science excites a wonder as to the means by which he could achieve so much. He made no claim to great mathematical ability, and many an experimenter has had fingers more clever than his. Yet he conceived and carried out a series of researches which have played a leading part in the marvellous advances of modern physics. To begin with, he brought to his work an intense interest, a tireless vitality, a singleness of purpose, a simplicity of conception and a bravery of attempt which carried him straight to the point.

Rutherford had to a remarkable degree the power of seizing on the essentials ; and he not only saw what was unimportant but also rode over it and through it remorselessly. This was true indeed of all his dealings : he had a well-earned reputation for speaking plainly. But he was very kind and generous, and a loyal friend. He was tactful, and full of consideration for all who were trying to do the right thing. One of his lovable characteristics was his constant care that all who worked for him, and indeed all workers, should have full credit for what they did. In any company of men he was extraordinarily quick to appraise the value of what each man said, and indeed the worth of the speaker himself, so that his own clearness and honesty of purpose, his force of statement and his shrewd judgment would carry the company with him. Thus he was a great administrator and guide.

In the laboratory his helpers went forward strongly and confidently towards the conclusions which he himself anticipated so clearly. So perhaps we may understand why such fine work came from the laboratories which he successively controlled, and why in these days physical science has been so greatly enriched. W. H. BRAGG.

WITH the passing away of Lord Rutherford*, the life of one of the greatest men who ever worked in science has come to an end. For us to make comparisons would be far from Rutherford's spirit, but we may say of him, as has been said of Galileo,

*A short tribute given at the Galvani celebrations in Bologna on October 20.

that he left science in quite a different state from that in which he found it. His achievements are indeed so great that, at a gathering of physicists like the one here assembled in honour of Galvani, where recent progress in our science is discussed, they provide the background of almost every word that is spoken. His untiring enthusiasm and unerring zeal led him on from discovery to discovery, and among these the great landmarks of his work, which will for ever bear his name, appear as naturally connected as the links in a chain.

Those of us who had the good fortune to come into contact with Rutherford will always treasure the memory of his noble and generous character. In his life all honours imaginable for a man of science came to him, but yet he remained quite simple in all his ways. When I first had the privilege of working under his personal inspiration, he was already a physicist of the greatest renown, but nevertheless he was then, and always remained, open to listen to what a young man might have on his mind. This, together with the kind interest he took in the welfare of his pupils, was indeed the reason for the spirit of affection he created around him wherever he worked.

Rutherford passed away at the height of his activity, which is the fate his best friends would have wished for him, but just on account of this he will be missed more, perhaps, than any scientific worker has ever been missed before. Still, together with the feeling of irreparable loss, the thought of him will always be to us an invaluable source of encouragement and fortitude. NIELS BOHR.

RUTHERFORD's death removes from science the most outstanding personality of the age. My most vivid memories naturally date from the autumn of 1900 and the two subsequent years when I worked with him at McGill. A born experimenter, entirely devoted to his work and with few, if any, outside interests, I can see now more clearly than I did then how he neglected no opportunity or preparation the better to advance it. Though the qualities for which in later life he was so publicly beloved were then still undeveloped, yet undoubtedly they existed and they helped to leaven the McGill of those days and to make it the enchanted place it was. The personal familiarity with the man, and his methods of work in the laboratory, that I gained in those years remained, of course, an abiding possession. Yet I do not think it was entirely, if at all, this that later was to make all his scientific communications a unique pleasure to read. True, admiration for some new and striking advances was pretty sure to be evoked, but over and above this they seemed to radiate an entirely undefinable charm.

In the last phase, since the Great War, this extended from his writings to his public lectures and appearances. The intense absorption in abstruse scientific problems, which in others is a hindrance to wide social intercourse, was in him combined with such vitality and magnetism that others were attracted rather than repelled. As has been well said, he was able to vitalize any public gathering and make it the happier merely for his coming.

In the last letter I had from him, asking me why I had resigned, he told me he did not expect to do so for some years, as he was feeling very fit and well, and able to hold his job down. The Fates have otherwise decreed. He reached, perhaps even did not quite reach, the summit of his powers, but for him there was to be no slow and inevitable decline. F. SODDY.

IT is hard to think of Rutherford as a man whose life is finished, that we shall no more see his steady eyes and hear the familiar voice, now asking placidly about some domestic trifle as any friend might, now growing hurried and excited when ideas about some physical problem were coming almost too fast for his tongue. There can seldom have been a man in whom burning genius was so closely associated with the kindly commonplace, who at any moment might suddenly become inspired, and a little later might be showing a boyish naïvety about some question of another kind. His ability to excite affection was as marked as his power of commanding admiration: his foibles were essentially those of a frank and simple nature, the charm of which remained unspoiled, and was even enhanced, by successes that might well have turned the head of a lesser man.

I like to think of him as he was at Manchester, where I first came to know him. Of this time he might have said, in Newton's words, "for in those days I was in the prime of my age for invention, and minded philosophy more than at any time since." He was free from any grave cares of administration, his duties outside the laboratory were light, and he had leisure himself to experiment with his own hands and eyes, as he loved to do. He organized his students as a team for radioactive research, allotting to each a task within his capacity, and urging him on in energetic fashion if urging was needed. Our belief in him was implicit: if Rutherford said that an experiment could be done, then it could be done, and the sooner it was done the better.

Rutherford was a young man with the rest of us, sharing our jokes and showing us how to overcome our difficulties. His nickname in those days was "Papa", perhaps arising from the paternal way in which he put us right about anything that had to do with radioactivity. But he was a very young father of a family and extremely unconventional. When things were going well, and new discoveries were coming out at the rate of about one a week, a tune recognizable by the elect as "Onward, Christian Soldiers" could be heard accompanying the Professor's steps along the corridors: when things were going less well another tune, no less holy, held sway.

It must not be thought that his interests were limited to radioactivity, or to any other particular branch of physics. I well remember him cross-examining A. D. Fokker about relativity, and any other visitor had to tell him all about the work in which he, the visitor, was expert. The theme of the laboratory in the few years before the Great War was, however, the structure of the nuclear atom, which he had put forward in 1911. In the laboratory during this period were Niels Bohr, H. G. J. Moseley, C. G. Darwin, J. Chadwick, H. Geiger, H. R. Robinson, J. M. Nuttall, E. Marsden, D. C. H. Florance, J. A. Gray, R. W. Boyle, H. B. Boltwood and A. Kovarik, to quote a few remembered names. Those were good days. Other great men will, no doubt, arise, but it is unlikely that any of us who worked with him in those days will live to see another such genius at the height of his powers, the leader and friend of such a school. E. N. DA C. ANDRADE.

LORD RUTHERFORD'S death is a calamity for the Department of Scientific and Industrial Research. In the seven years during which he has been chairman of the Advisory Council, his influence has made itself felt throughout the Department. His broad sympathies, lively imagination, and deep insight equipped him in a wholly exceptional way to direct and strengthen the links between the Department and industry. It was an article of faith with him that the future of Great Britain depends upon the effective use of science by industry. It was this faith which induced him, a man of the highest attainment in the field of pure scientific research, to devote himself, as he did unreservedly, to our work. The development of the research association movement, now taking place, owes much to his foresight, sympathy and advocacy. Equally stimulating was his influence on the scientific work of the Department. In our counsels he leaves a blank which cannot be filled; and the loss of his unsparing service, his genial personality, and his warm-hearted encouragement, may well fill the stoutest heart with dismay. F. E. SMITH.

The Funeral of Lord Rutherford

WITHIN the ancient walls of Westminster Abbey and in the presence of a large gathering of men eminent in many walks of life, at noon on Monday, October 25, a typical English autumn day, the last remains of Lord Rutherford were laid to rest in the Nave near the graves of Newton, Kelvin, Darwin and Sir John Herschel. Thus another link was forged binding the Empire together, for Rutherford was the first man of science born in the overseas dominions to be buried in the Abbey. The honour thus accorded him is fitting recognition of the place he held among his fellows, and the memorable service at his burial, in its simplicity, beauty and dignity, was in keeping with the passing of a man of singleness of purpose whose whole life had been devoted to unravelling the secrets of Nature. There was no pomp or pageantry such as is seen at the burial of our great naval and military leaders, no word was said of his life or achievements, but a quiet air of sincerity pervaded the whole scene and left an indelible impression that it was all as he would have wished.

Among the large congregation, H.M. the King was represented by Lord Fortescue (Lord in Waiting). The Prime Minister was represented by Mr. G. P. Humphreys-Davies, the Lord Chancellor by Mr. Vernon Harington. Lord Halifax (Lord President of the Council), Lord Swinton (Secretary of State for Air), Sir Samuel Hoare (Secretary of State for Home Affairs), Sir Thomas Inskip (Minister for Co-ordination of Defence), Earl Baldwin and Mr. Ramsay MacDonald were present. Rear-Admiral A. Bromley represented the Secretary of State for Dominion Affairs and Admiral of the Fleet Lord Chatfield represented the Admiralty.

The ten pall-bearers were the High Commissioner for New Zealand, Prof. H. R. Dean (Vice-Chancellor of the University of Cambridge), Lord Dawson of Penn (president of the Royal College of Physicians), Sir William Bragg (president of the Royal Society), Sir Edward Poulton (president of the British Association), Prof. A. S. Eve, of McGill University, Prof. E. D. Adrian, of Trinity College, Cambridge, Sir Frank Smith, of the Department of Scientific and Industrial Research, Prof. W. L. Bragg, of the University of Manchester, and Sir George Lee, president of the Institution of Electrical Engineers.

The service began with the singing of the sentences "I am the resurrection and the life . . ." while the coffin containing the urn with the ashes was borne slowly through the Nave and Choir to the bier placed in front of the Sanctuary and beneath the Lantern. Then followed the singing of the 23rd Psalm, the reading of Ecclesiasticus, xliv, 1–14, prayers and the hymns "The King of Love my Shepherd is" and "Praise, my soul, the King of Heaven". With the congregation standing, the coffin was then carried back to the Nave, followed by the mourners and chief representatives, and the committal took place. Owing to the recent death of the Dean, the Right Rev. W. Foxley Norris, the service was conducted by the Sub-Dean, Canon V. F. Storr, and it was his voice the congregation last heard as he pronounced the Blessing. The service was brought to an end with the organist playing Harwood's *Requiem Æternam*. After the departure of the chief mourners, those present were permitted to file past the flower-strewn spot where the urn rested, and above which will be placed the slab bearing the name of Rutherford.

On this occasion it is of interest to recall something of the other eminent men of science buried or commemorated in the Abbey ; for as Dean Stanley wrote, the characteristic of Westminster Abbey which most endears it to the nation is the fact that it is the resting place of famous Britons, from every rank and creed, and every form of mind and genius. The earliest connexion of the Abbey with modern science and with the Royal Society goes back to the seventeenth century, when Sir Robert Moray, the first president of the Royal Society, was buried in the centre of the South Transept at the expense of Charles II. He died in 1673. Two years later, Dr. Thomas Willis, one of the earliest professors of natural philosophy at Oxford, was buried in the Abbey, and his interment was followed in 1677 by that of Isaac Barrow, the first Lucasian professor at Cambridge and the Master of Trinity. Both his grave and monument are in Poets' Corner. Just half a century separate the burials of Barrow and of Newton ; but in the interval Dean Sprat, the first historian of the Royal Society, was buried in St. Nicholas's Chapel, and Thomas Tompion, 'father' of English clockmakers, was buried in the centre of the Nave.

Newton died on March 20, 1726 (O.S.) or March 31, 1727 (N.S.). For several days his body lay in state in the Jerusalem Chamber and then was buried on the south side of the Nave near the Choir. "His countrymen honoured him in his lifetime," wrote Voltaire, who was in London, "and interred him as though he had been a king who had made his people happy." Though there are memorials to men of science in many parts of the Abbey, it is around the grave and monument of Newton that the greatest number are to be found. Just in front of the monument are the tablets to Kelvin, Maxwell and Faraday, a little farther off are the gravestones of Telford and Robert Stephenson, while in the grave of Tompion lies also the body of his pupil and successor "Honest" George Graham, who on November 24, 1751, at night, was brought from his house in Fleet Street and laid with his master. To the north of Newton's grave, in the Aisle, are the graves of Darwin and Herschel, and a little farther to the west those of Lyell and John Hunter. Like Boyle, Hunter was first buried in St. Martin-in-the-Fields. Boyle's grave was lost sight of through the rebuilding of the church, but Hunter's coffin in the vaults of the new church was discovered by Frank Buckland, and through the action of the Royal College of Surgeons in 1859, was removed to the Abbey.

Also in the north aisle, but to the east of the grave of Darwin, are the eight memorials clustered around the tomb of Sir John Thynne, a zealous Sub-Dean of the Abbey. Here in 1888 was placed the medallion of Darwin, and beside that are now memorials to Joule, John Couch Adams, Sir Joseph Hooker, Alfred Russel Wallace, Sir George Gabriel Stokes, Lord Lister and Sir William Ramsay. The ten windows lighting the aisle are also memorials, and on some of them are to be found the names of Richard Trevithick, Isambard Kingdom Brunel, Robert Stephenson, Lord Kelvin, Sir Benjamin Baker and Sir John Wolfe-Barry. There were once windows to the memory of Joseph Locke and Sir William Siemens, but these have been removed.

Of the other memorials in various parts of the Abbey, the group in St. Andrew's Chapel is the most interesting, for here, beside the statue of Telford, are the tablets to Sir Humphry Davy, Thomas Young, Dr. Matthew Baillie the anatomist, Sir James Simpson and Lord Rayleigh, and also the monument to Sir John Franklin. Not far away, in St. Paul's Chapel, is to be found Chantrey's great statue of Watt, whilst elsewhere are to be found the graves or monuments of Sir William Spottiswoode, Sir John Pringle and Martin Folkes, three presidents of the Royal Society, John Woodward and Dean Buckland, Major James Rennell, Sir Stamford Raffles and the young Lancashire clergyman and astronomer Jeremiah Horrocks, who on November 24, 1639, was the first to observe a transit of Venus. Horrocks died in 1641, but at the time of the transit of 1874 a memorial, placed within that of Newton's nephew, John Conduitt, at the west end of the Nave, was erected with an inscription upon it by Dean Stanley.

Science and the Community*

By the Right Hon. J. Ramsay MacDonald, P.C., M.P., F.R.S.

I MUST begin by expressing two things that are upmost in my mind at this moment: the thanks we all owe to Mr. Radford Mather, the generous founder of these lectures, and the honour I feel at having been asked by the Council of the British Association to deliver the first of them. Mr. Radford Mather has been impressed by the importance of the work of the scientist in the ordinary everyday life of our people, especially at this moment; and, after a long life enlivened by scientific and social interest, he feels keenly that a recognition of that work is not only owing to the scientific worker himself, but also will be helpful in inducing the public to use the advantages which the scientist has put at its disposal.

The history of scientific discovery and the application of scientific knowledge to human activities in every field reads like a romance, and I can imagine no more interesting career for anyone whose tastes lie in that direction. The interest and importance of the scientific career, however, are not confined to the laboratory or the classroom, but should be regarded as a major, if indeed not the major, creative influence on this generation. In national economic well-being, especially in making high standards of living possible, in the evolution of both the powers and forms of national institutions, in the efforts to create and secure social harmony and co-operation, the scientific method, if followed, would be of great assistance and would save some futile experiments, mistaken agitation and unworkable proposals. Thus, the politician as well as the professor, the housewife as well as the manager of great works, whether they are aware of it or not, depend in the performance of their work upon whether the public mind not only responds emotionally but also sets about making that response with the same care as to facts and the same anxiety as to methods as the man of science shows in his special field. What are called 'moving' descriptions of human ills, quite accurate as to facts but left without carefully studied conclusions as to treatment, often become serious obstacles in the way of satisfactory remedies.

In all public affairs I myself am an unrepentant evolutionist. There must be changes, not for the sake of change, but because social harmony and progress require it. Were it not so, civilization itself would soon become a relic, and we should have to deal with a society which has breathed its last progressive breath and has reached the stage of disruption through evolution, because it is not adapting itself to the new conditions which are the immediate offspring of its own life. Civilization is not a static state but one of dynamic activity which requires direction. The most lasting and fruitful of changes are those which arise from the failures of existing conditions or their hitherto imperfect successes. Or we may put it this way in full accordance with the truly scientific mind: Creation was left imperfect for man to carry it on towards completion by coming to understand it, both as an accomplishment and a promise. The place where the shoe pinches either body or mind is the spot where disruptive unsettlement shows itself first. The remedy is not to curse the shoe nor to content ourselves by describing the pains. The shoe should be adapted so that it may be useful (as it was intended to be) without doing what it was never meant to do—rack us with pain.

Pain in the individual corresponds with discomfort and unrest in the community. Both are signals of harmful processes and call for study and treatment in the scientific spirit, in order to prevent more serious results—serious illness and death in the individual, revolution and disruption in the community.

By the scientific method it might often be possible to prevent even the pain and unrest. This optimism in progress, however, assumes that an awakened interest in the work of the experimental scientist will incline the public to follow, in its own special concerns, the methods and spirit of the scientist himself. I make no plea for the scientist as statesman. He will not be likely to be any better than Plato's philosopher. The plea I make is for a practical democracy, but if democracy is to triumph in the attack now being made upon it, it must have a method, and I believe that the records of the scientific worker and the way he sets about his work will steady and clarify the popular mind not only to complain eloquently, but also to conclude wisely.

In these days, when science is renewing its claims to be regarded as an essential part of cultural education and to rank in value with the humanities for that purpose, it must be able to show that its pursuit is not only to discover facts, but to influence values of life as well, and that it can not only put power into men's hands, but also quicken the human qualities of mind which take care that that power is used for human well-being

* From the first Radford Mather Lecture of the British Association, delivered at the Royal Institution on October 22.

and progress. The scientist as citizen should take a lively concern in the way his discoveries are used. Prof. Lancelot Hogben contributed a thought-provoking paper to the Blackpool meeting in which he emphasized this dictum : "The cultural claims of science rest on the social fact that the use and misuse of science immediately affects the everyday life of every citizen in a modern community."

If at the end of a generation the great contribution that scientific activity has made to the life of the community is to produce a power of destruction which can be used to appal the most indifferent to human suffering and injustice, the labours of the scientist of our time run the risk of being permanently deplored. This is now being widely recognized by scientists themselves. On the other hand, the part which our present scientific research can play in social well-being and solidarity depends upon an enlightened popular view of the value and significance of those researches and their uses.

Standards of life have undoubtedly been raised and opportunities for improving wages provided, whilst leisure has been extended and the conditions under which people work, even in spite of some serious shortcomings, greatly improved. Human stress and strain have become considerations in work, and the adaptability of the individual to employment has greatly eased the discomforts and disappointments of the worker. These tendencies have by no means exhausted themselves, and an enlightened determination to maintain the conditions of uninterrupted consumption of products by increasing the share of the worker will minimize the hardships of any at-present-uncontrollable slackening in the market demands for production and labour.

The needs dealt with by these scientific investigations cover an extraordinarily wide field indicated with interesting clarity in the annual reports of the Department of Scientific and Industrial Research and its organizations, such as the National Physical Laboratory. From these it is seen that organized research extends apace, and that the co-operation between scientists and industrialists has become a well-marked feature in our industrial life. Industry is no longer satisfied with sporadic consultations with science. This has led, as the last annual report of the Department of Scientific and Industrial Research records, to a steady improvement of the efficiency of our industry and the comforts of the working staffs.

Furthermore, there is a steady growth of the acceptance of scientific effort on the part of industrialists, and a spirit of co-operation between the scientist and industrialist has been developed to an encouraging degree, so much so that we may well say that we have been witnessing the creation and development of a new industrial organ with a well-marked function.

I must limit my excursion into those fields to which modern scientific discoveries are leading us, which have been so interestingly dealt with in papers read at the Blackpool meeting of the British Association last year, and which find a voice in some most challenging articles in recent issues of the scientific press. Nor will scientists fail to observe the meaning of that most significant resolution passed by the recent Trade Union Congress agreeing to a Committee of Scientists with whom Congress can consult on policy, outlook and methods of handling their special work. Thus a scientific front is being created, with the co-operation of all classes and interests, to encourage scientific inquiry and to use it to promote communal well-being.

The advance in the investigations of the scientist is not, however, universally welcomed. The reason is that science and machinery mean pretty much the same thing in the public mind, and two accusations are made against machinery which are in very many minds as they see what wonderful things science has done in recent years. The first expresses a general doubt whether this machine age has brought us any benefit at all, and is anything more than an unfortunate by-road in world history. It is argued that, in pursuing the machine, man has lost his soul and those qualities which proved that he had a soul. That great question in æsthetics cannot be dealt with in this lecture even as a side issue. I believe that a very large part of the case for it is based upon the misuse of science for which the man of science has nothing to do, and cannot be blamed. But, further than that, I am not at all sure but that science will be found to provide the antidote—conditions of leisure and culture which will enable us to rediscover the qualities of life which modern society is said to have lost.

In many quarters science is regarded as the enemy of human beings who desire to live as self-supporting workers. So has it always been at times of great change in industrial production. A reply which reminds us of the experiences of labour in history, that the displacement of men by machinery has always been but temporary and that with an increase in national wealth we also have an increase in the national demand for labour. There is some evidence that that experience is being repeated to-day. It is, however, rather unconvincing to the man who actually finds himself unemployed because a machine more efficient than himself as a producer has taken his place in mine and factory. Be that as it may, machinery which takes the place of the hard, uninspiring and deadening drudgery of human beings is all to the good, and that which multiplies the efficiency of human skill is also all to the good. Human safeguards and benefits come from other directions—mainly from an increase in leisure, the enjoyment and use of which are amongst the most pressing of social problems to-day. And there is another pressing problem in front of us. How to reduce cost of production without lowering standards of life ? Scientific invention properly used, I believe, will give us a chance to solve both problems.

The other trouble is kept fresh and urgent by what we read every day in our newspapers of the great advance due to science in the destructive forces of the world, as shown in China and Spain, and will be repeated with increased horror wherever war breaks out. If we cannot avoid war, we cannot avoid the very worst that can happen in warfare. But this raises issues which depend upon other considerations than those of the field of science. Science increases power which can be applied both to life and death. The men who have made air forces possible, for example, have also created civil air fleets, and if the communities cannot make and keep peace, or if they are so blind as to follow the aggressive actions of their rulers, democratic or dictatorial, the consequences are theirs. If peace is not secured by, say, diplomacy and the will not of one but of all nations, it is both a false judgment and a cowardly one to blame the scientific engineer and worker. The action of the farmer in growing corn and food for war is exactly of the same kind as the engineer who makes flying engines. Peace or war is not the responsibility of scientists *as scientists*, except in very special cases, so long (and it will always be) as the discoveries which increase our peaceful and beneficial resources can be used for war machinery.

At the same time, there is a feeling amongst many scientists that the ease by which their labours may be misused in this way should make them, as citizens, sharers in creating and upholding the public opinion of the nations to which they belong, interested in protecting their work from being outrageously abused as beneficial poisons can be.

I have presided over various international conferences of chemists, engineers and others interested in this question, and one and all gave a hearty response to every mention of this interest and duty of theirs. Scientists will also remember that from that distinguished scientific body, the Royal Academy of Sciences at Amsterdam, came a resolution which after discussion at the general assembly of the International Council of Scientific Unions, in April last, led to the appointment of a committee with the following terms of reference :

"The Committee, at suitable intervals, should prepare a survey of the most important results obtained and of the directions of progress that are opening and of points of view brought forward in the physical, chemical and biological sciences, with reference to :—
"(1) their interconnections and the development of the scientific picture of the world in general ;
"(2) the practical application of scientific results in the life of the community.

"The work of the Committee is limited strictly to scientific activity." (See NATURE, April 24, 1937, p. 697, and May 22, 1937, p. 869.)

This is the concern of the political organization of citizens, including scientists, but not specifically as scientists. In any event, we ought to be careful not to go upon altogether false scents, or set up issues which are too narrow to end the ills from which we suffer. We can go back to bows and arrows but that will not remove the grievances of nations for which they will fight, nor supply the enlightened diplomacy which can keep the peace without injury to a nation's sense of injustice. Do not let us be misled by thinking that the scientist as such can stop war. The military leader can use the triumphs of science to disgrace warfare. That is all. In any event, science cannot cease to follow the exhortation of Carlyle to "Produce in God's name", and it would be bad for humanity generally if it tried. It is not scientific to deal with the offshoots of evil. The scientific method goes to their roots.

Let us face our present conditions in the historical and biological spirit, and much progress in the science and art of applying science to society and government can be recorded. I am familiar with the complaint that the average scientist in Great Britain has been in despair about his difficulty of getting the discoveries of science which directly affect public welfare appreciated by Government. It would be well for Governments to remove this grievance so far as it is sound, and the creation of the Departments which I have mentioned is a start in better conditions and prospects, and is already having a beneficial effect on administration. Still, departmental contacts with science ought to be extended without delay, and India and the Empire—especially the Colonial Empire for which we have more direct responsibility—should not be overlooked, as indeed everyone acquainted with the work of Manson and Ronald Ross knows has not been done.

It must be evident to everyone who has thought about the social consequences of advances in scientific research that they call for a reinvigoration of social science. The experience of later years points out the urgent desirability for close co-operation between the scientist, the industrialist, and the man of affairs, to enrich the lives of human beings, to help such changes as will diminish the disruptive forces in society, and to promote social solidarity which lies at the root of human progress and happiness.

The Biology of Crossing-over

By Dr. C. D. Darlington

SEXUAL reproduction consists of two alternating processes: *fertilization*, by which two germ cells containing each a single set of chromosomes fuse and produce a zygote with the double number of chromosomes, and *meiosis*, by which the double number is reduced and germ cells are again formed with the single number. As Weismann first pointed out, the biological importance of these processes is that they enable the hereditary differences between the chromosomes to be recombined in the greatest number of ways to give the greatest number of different individuals and therefore the greatest scope for natural selection to act in directing evolutionary change.

In recent years we have come to know precisely how this recombination takes place, not merely in one organism, but probably in all sexually reproducing organisms. The method is both more complicated and more efficient than Weismann imagined. In the mother-cells which are to undergo meiosis, the chromosomes are present as single, instead of the usual double, threads of particles. By a combined study of ultra-violet photographs of the particles in *Drosophila*, and of the genetic effects of breaking the threads with X-rays at a series of points along their length, the particles have been identified as genes, the atomic units of heredity[1]. The chromosome threads correspond, as we should expect, in pairs, and come to lie side by side in pairs, gene by gene. Their attraction is therefore specific. They then coil around one another, and this coiling proves that they have two properties that might well be expected of them. It proves that they are each in a state of torsion such as that which determines the ordinary contraction of a chromosome into a rod-shaped body at mitosis. It proves also that the threads do not slip around one another. They stick together like two threads of wool placed side by side. The attraction of their genes for one another must therefore be specific in position, that is, not merely between the genes but between the parts of the gene[2].

If we imitate the physical condition of the chromosomes while they are paired and coiled by placing two woollen threads under torsion side by side, we find that they coil round one another but at the same time necessarily uncoil themselves internally. The relational and internal coiling (as we may call them) are opposite and in equilibrium. The stability of this system is attested by its use in all spinning operations.

The coiling equilibrium of the paired chromosomes is upset by their division, and we then find that the half-chromosomes, or chromatids, arising in this way are as we should expect coiled round one another. But other changes take place at almost the same time as the division and are presumably determined by it. First, the divided chromosomes separate: they no longer attract one another. Secondly, chromatids of partner chromosomes break at opposite points and the broken ends uncoil and rejoin so that exchanges of chromatids occur between the separating chromosomes. The chromosomes, although no longer attracting one another, are held together by these exchanges, or chiasmata, which appear in varying numbers and positions in different chromosomes and in different cells.

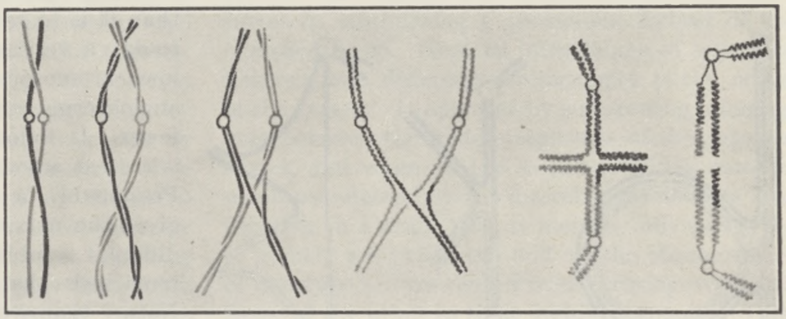

Fig. 1.

Diagram showing the series of changes by which crossing-over determines chiasma formation and the later association, orientation, and separation of a pair of chromosomes. The circles represent centromeres or spindle fibre attachment chromomeres.

The special mechanical situation of chromosomes dividing while they are paired thus determines the breakage and reunion which we call crossing-over. In the absence of crossing-over the partner chromosomes fall apart and are unpaired at all later stages. On this process, therefore, the later reduction in number and segregation to opposite daughter-cells equally depend (Fig. 1). Thus crossing-over, which is the only regular genetic change that the chromosomes undergo in their history, is the immediate condition of reduction and segregation, which are the external changes essential for sexual reproduction. Special exceptions to this rule we will consider later.

Crossing-over within every pair of chromosomes is thus essential to sexual reproduction, but, leaving out this primary consequence, we can sort out its secondary biological consequences into several convenient groups.

First we must take the simple effect of crossing-over in recombining parts of chromosomes, the effect which has been made the basis of genetic analysis in *Drosophila*. Without crossing-over, each chromosome would be a permanent individual, varying and being selected as an individual like a plant clone or any other asexually reproducing organism. With crossing-over, the individual unit of variation and selection will be the unit of crossing-over, which in practice is the gene. Cytological observation has therefore shown that

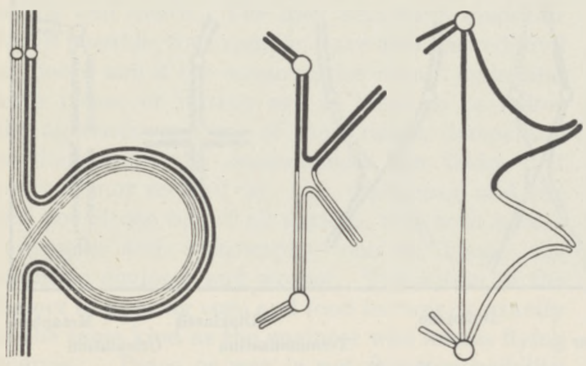

Fig. 2.

DIAGRAM SHOWING THE SERIES OF CHANGES BY WHICH A PAIR OF CHROMOSOMES, DIFFERING IN REGARD TO THE INVERSION OF A SEGMENT, HAVE CROSSING-OVER IN THAT SEGMENT WITH THE CONSEQUENT FORMATION OF ONE DICENTRIC AND ONE ACENTRIC CHROMATID.

the gene structure established by crossing-over experiments in *Drosophila* is applicable to all sexually reproducing organisms. The sizes of the genes and their physiological activity or inertness will be different in different organisms, but their methods of inheritance, variation and selection will be essentially similar. We may expect, for example, that, as in *Drosophila*, chromosomes or parts of chromosomes in which crossing-over is reduced or suppressed will mutate to an inert state in which they will continue until by chance breakage they are lost[3].

One respect in which species differ most significantly is in the amount of crossing-over taking place in their whole chromosome complements. This is one factor affecting the amount of total recombination that will take place among the genes at meiosis. The other factor is the number of pairs of chromosomes themselves. By adding this number to the average total frequency of chiasmata in the mother-cell, we can obtain a *recombination index* which will be a measure of the average total number of independently segregating gene-blocks in the species. This index is 6 in male *Drosophila melanogaster*, 12 in the female, 36 in *Zea Mays* and about 75 in man[4]. It is clear that these enormous differences will affect the character of variation in a species, though in what way it remains for us to find out.

One general property of the recombination index may be noted. A low index has a positive selective value. This may be shown in the following way. The chiasma frequency is under genotypic control ; it is therefore capable of selection and is usually as low as is consistent with regular pairing of the chromosomes. On the other hand, it is much easier to increase chromosome numbers, both by doubling individual chromosomes and whole sets, than it is to reduce them. Nevertheless we have to-day a very large proportion of organisms with low chromosome numbers. More than half the angiosperms have twelve pairs of chromosomes or fewer. It follows that while some recombination is a great advantage, too much is a disadvantage. Presumably a certain stability in combination gives the maximum efficiency in the selection of different combinations. In this regard Fisher has remarked[5] that there is more crossing-over in Nature than would seem desirable. The reason is now clear : each pair of chromosomes has to have at least one chiasma in order to undergo meiosis.

There is another genetic effect of crossing-over that is entirely different from that of recombination ; namely, its effect in certain kinds of structural hybrids. Most organisms that have not been closely inbred are structural hybrids of one kind or another. The commonest kind is the inversion hybrid, which has a segment of a chromosome inverted relative to its partner. When crossing-over takes place within such a segment two new chromatids are produced, one joining the two centromeres of the chromosomes and the other joining their two ends and lacking any centromere (Fig. 2). When the bivalent formed in this way attempts to divide, the 'dicentric' chromatid forms a bridge between the daughter nuclei, and the 'acentric' one, incapable of movement, is lost. The bridge may break anywhere along its length, so that new chromatids are produced having some genes in excess and others lacking. Thus the primary structural change of inversion gives rise to secondary changes such as reduplication and deficiency. These are changes of 'balance', and rank with intra-genic changes and position changes as one of the three effective means of variation. The original variation becomes the basis of future variability. This does not mean that variation within an endogamous group will be cumulative. Equilibrium is presumably reached by the effect of structural change in decreasing fertility, or a new system is established by the breaking up of the group into two smaller genetically isolated groups, that is, by the fission of the species. This property of genetic isolation brings us to the last important relationship of crossing-over.

So long as we have a structurally homozygous stock with crossing-over taking place at intervals between all the varying genes, no stable combination of variants can be maintained without elimination of cross-overs and loss of fertility. Optimum adaptation always demands such a combination, for adaptation depends on the integration of the whole gene system. The most generally recognized way of securing stable combinations is by geographical or ecological isolation. In the same way inter-sterility may secure a genetic isolation of two types of combination. All these methods depend on an isolation of zygotes. But an equally important method is the isolation of chromosomes or parts of chromosomes by structural change. When a small inversion or translocation occurs in one chromosome of a species, crossing-over is restricted or abolished between this changed segment and its normally arranged partner. Any gene differences occurring within this segment are held together in a more or less permanent combination. A new unit, a new order of integration, is established in this way.

It is through this special type of unit that three important types of discontinuity arise in Nature. The simplest type is that by which two groups which remain interfertile diverge within a species. It is probably the basis of the discontinuity between *Avena fatua* and *Triticum Spelta* and their allied forms, which differ essentially in a group of genes lying in a part of one chromosome. A second type is that by which the sex-determining chromosomes (X and Y) come to be distinguished. Originally one pair of genes in these chromosomes determines the sex difference by their segregation. Later other genes become associated with them in two groups which show no crossing-over. Their crossing-over may be suppressed structurally by an inversion or some other similar change. It may also be suppressed genotypically, and here we come to the exceptions in which crossing-over does not take place at meiosis at all. This situation arises in the heterozygous sex in certain insects where a new pairing mechanism is introduced instead of chiasmata. It is only one sex, however, that is affected, and this shows us that in the last resort it is not chiasmata which are indispensable for meiosis but crossing-over which is indispensable for the species. The exclusion of one sex from crossing-over has a special effect on one chromosome, the Y-chromosome. Where sex is determined by the segregation of X and Y, the Y, being confined to the heterozygous sex, is permanently excluded from crossing-over. The result of this is shown in evolutionary series when we compare different animals. First the Y becomes inert as in *Drosophila*, later it becomes smaller as in the Mammalia, finally it is lost as in many Orthoptera[3]. The intermediate stages show different transitions according to the positions in which crossing-over is localized before its eventual suppression. In whatever way crossing-over may lapse, a group discontinuity arises between the two sex-determining chromosomes. This discontinuity differs in its effect from that arising between species merely in that the two types it distinguishes are mutually adapted for sexual reproduction[6].

The third type of discontinuity occurs in plants. It is that which arises between chromosomes in establishing a permanent hybrid of the *Œnothera* type. Here an interchange of segments between two different chromosomes is the origin of the system. It operates by suppressing crossing-over between the middle segments of the chromosomes, and when all the members of the complement are affected by the interchanges and are held together in a single ring at meiosis, only two types of gamete are produced, and all the chromosomes of one type are prevented from crossing-over with those of the other in their middle segments. Thus complex differences arise owing to the isolation not of zygotes nor of parts of one pair of chromosomes but of parts of all the chromosomes of the gamete, a gametic isolation. The differences between the two gametes are of the same order as the differences between two species.

Other mechanisms occur in the dog roses and with certain kinds of parthenogenesis whereby, as in *Œnothera*, a large part of the genes are prevented from recombining. With such systems stability has been achieved at the expense of variability, and we have arrived at what we may call a subsexual method of reproduction.

In these various ways and in many others the study of crossing-over shows us that this simple and universal mechanical property underlies most of the important relationships with which we are concerned in genetics. Variation and adaptation, hybridity and discontinuity, sex-determination and species-formation operate and develop according to the varying occurrence or suppression of crossing-over. Crossing-over is the primary variable in the evolution of genetic systems.

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[2] Darlington, C. D., *J. Genet.*, **31**, 185–212 (1935).
[3] Darlington, C. D., "Recent Advances in Cytology" (London, 1937).
[4] Koller, P. C., *Proc. Roy. Soc. Edin.*, **57**, 194–214 (1937).
[5] Fisher, R. A., "The Genetical Theory of Natural Selection" (Oxford, 1930).
[6] Muller, H. J., *Amer. Nat.*, **66**. 118–138 (1932).

News and Views

Sir P. C. Rây, C.I.E.

SIR PRAFULLA RÂY has retired from the Palit professorship of chemistry at the University College of Science, Calcutta, a post which he has held since 1916, and has been elected professor emeritus. His retirement is a noteworthy event in Indian science. The whole of Sir Prafulla's active life has been spent in Calcutta. After receiving his early training in chemistry at the Presidency College under the late Sir Alexander Pedler, he worked for some years in Edinburgh under Prof. Crum Brown, graduating there with the degree of D.Sc. On returning to Calcutta he in due course succeeded Sir Alexander Pedler as professor of chemistry at the Presidency College, where he remained until his retirement from Government service in 1916. Sir Prafulla's own investigations, carried out in collaboration with numerous students, were for many years concerned mainly with the chemistry of the nitrites, to which he made a notable contribution, whilst more recently he has added to our knowledge of thio-compounds and metallic complexes. Sir Prafulla was the first to organize in India a true school of chemistry; he gathered around him a brilliant band of workers whom he imbued with his own enthusiasm for scientific research. Many of these have attained positions of eminence.

THE activities of Sir Prafulla Rây, however, have not been confined within the laboratory walls. He found time to write a history of Hindu chemistry, which has become a classic, and to found, and become honorary director of, a large chemical works, the Bengal Chemical and Pharmaceutical Company. In his later years he has been much interested in political and social questions. His students have for him an extraordinary veneration and affection, which is not surprising since he embodies all that is best of the true Indian "Guru". Outward marks of the esteem in which he is held have not been lacking; he was appointed C.I.E. in 1912 and knighted in 1919. He was president of the Chemistry Section of the Indian Science Congress in 1915 and of the Congress in 1921, whilst he was the first president of the Indian Chemical Society (1924–26). In 1933, in celebration of his seventieth birthday, the Society published a commemorative volume, to which contributions were made by chemists of all nationalities. Into his well-earned retirement Sir Prafulla will take with him the best wishes of all scientific workers.

British Association: Mather Lecture

MR. G. RADFORD MATHER, to whom the British Association owes the foundation of the Radford Mather lecture, is a retired engineer, now living at Wellingborough. Mr. Mather, who combines wide scientific knowledge with a deep appreciation of the necessity for social service, has many and varied interests. He has given special attention to the study of those forces which govern minimal surface relations, and it was during a correspondence dealing with such matters that the attention of Mr. Mather was directed to the increasing interest shown by the British Association in the repercussions of advances in scientific knowledge on the well-being of the community. Mr. Mather has endowed a triennial lecture, to be given in London or the provinces, to be called the Radford Mather lecture, and to deal, for the most part, with the social implications of the advancement of science. Mr. Ramsay MacDonald gave the first lecture of the foundation, and portions of his address appear elsewhere in this issue. The scientific world is much indebted to Mr. Radford Mather for this foundation, and it is a matter for regret that, in view of his great age—he celebrated the ninety-sixth anniversary of his birthday on October 17—he was unable to be present at Mr. MacDonald's address.

Science and the Community

IN the first Radford Mather lecture of the British Association entitled "Science and the Community" delivered at the Royal Institution on October 22, the Right Hon. J. Ramsay MacDonald paid an eloquent tribute to the value of the scientific method and its broad application to human needs. Science is one of the greatest creative forces of this generation, and the guidance of scientific research is indispensable in treating many of the ills arising in a civilization which is not a static state but one of dynamic energy calling for direction. The most lasting and fruitful of changes are those which arise from the failure or imperfections of existing conditions; discomfort and unrest in the community, like pain in the individual, are danger signals which call for scientific study and treatment. Such pain and unrest may even be preventable by scientific treatment, and while making no plea for the man of science as statesman, Mr. Ramsay MacDonald indicated a wide field in which the scientific method might assist in the development of a rational and broad policy. Health and the home life of the people are two directions in which fundamental changes and advances may be possible in this way, and he suggested, too, that the example of the scientific worker is in itself of value in steadying and clarifying the popular mind not only to complain eloquently but also to conclude wisely.

THE dual plea that the man of science as citizen should take a lively interest in the way his discoveries are used and that the contribution of science to social welfare depends upon an enlightened popular view of the value and significance of these researches and their uses, led to a final plea for a reinvigoration of social science, which is of special interest in view of Lord Nuffield's recent offer to the University of

Oxford for building a new college especially for social sciences. Mr. Ramsay MacDonald claimed that close co-operation between the man of science, the industrialist and the man of affairs is needed to assist the changes which diminish the disruptive forces in society and promote the social solidarity lying at the root of human progress. This reminder of the futility of blaming science and scientific workers for the horrors of war is equally timely. Although science has increased the power which can be applied both to life and to death, peace or war are not the responsibility of men of science as such, and they may well claim that by making war more widespread they have driven home the responsibility for warfare, which lies in the moods of man rather than in his mechanical inventions.

The Evolution of Torpedo Craft

It was but natural that in his presidential address to the Institution of Mechanical Engineers on October 22, Sir J. E. Thornycroft should deal with the development of torpedo craft. He was a child five years of age when at Chiswick his father, Sir J. I. Thornycroft (1843–1928) built the *Lightning*, the first torpedo boat in the British Navy, and he has thus witnessed the growth in size, speed and power of torpedo boats, torpedo boat destroyers and the newest motor torpedo boats. Together with Sir Alfred Yarrow and Jacques-Augustin Normand, of Havre, Sir J. I. Thornycroft was a pioneer of water-tube boilers, forced-draught and high-speed engines, and from the works he founded at Chiswick and Woolston have come many of the most notable vessels ever launched. Towards the end of his address, Sir John Thornycroft made some interesting observations on the skimming principle applied to boats, and on the need for simplification in warships. As is well known, the motor torpedo boat, first brought into use in the Great War, is of such a design that when sufficient speed is attained it skims or planes along the surface of the water. Some people think the principle might be applied to larger vessels, but Sir John pointed out that whereas a 50-ft. motor-boat will skim at 30 knots, a 300-ft. destroyer would have to attain a speed of 70 knots, and this would necessitate engines of 200,000 horse-power. Apart from the propelling machinery, ships to-day are filled with mechanism. The very complexity of this raises the question as to means by which it is to be kept in order, and this led to the suggestion that the work of mechanical engineers should be in the direction of simplification.

Co-ordination of Fuel Interests

In his presidential address to the Institute of Fuel on October 14, Sir Philip Dawson traversed the whole range of fuel-producing and fuel-using industries, pointing especially to the leakages and inefficiency resulting from the absence of co-ordination between the different interests. Although the different fuels are to a considerable extent complementary, the system of free competition leads to internecine conflict, while desirable goals such as the elimination of smoke and the greater production of liquid fuels receive inadequate attention. Such surveys have often been made in the last fifteen years, and Sir Philip comes, like others before him, to the conclusion that the Government should set up a strong central advisory body to co-ordinate the fuel activities of Great Britain. Hitherto, such proposals have passed unheeded, but now he holds that the national interest demands action. Coal should become the raw material for satisfying modern demands in new form. The future requires a smokeless, pure atmosphere in which to live, and suitable solid, liquid and gaseous fuels for every side of national activities.

The Appraisement of Lighting

For the twenty-second Guthrie Lecture before the Physical Society on October 22, Dr. C. C. Paterson discussed "the Appraisement of Lighting". Dr. Paterson pointed out that as techniques have become available during the past thirty years, the art of appraising lighting has changed and advanced greatly. Like so many other subjects, however, that of lighting and seeing has been and is held in check by the inevitable tendency of those who practise it to define it at any epoch in terms of the quantities which they understand. Whereas research can stretch out where it pleases, it is difficult for a practical art to advance faster than the established techniques for appraising its merits. The earliest standard ever adopted, specifying a candle of a certain weight in a lantern, is one which has many advantages and which under a changed form is still probably the most widely adopted. The most easily measured characteristic of a light source is luminous intensity, but a measure which is of more value in estimating the aid to seeing is that of luminous flux. With the advent of differently coloured light sources difficulties of such measurements have grown. The adoption of an internationally accepted relative luminosity curve for the average human eye has brought the measurement of intensity of illumination to a high state of accuracy for sources with continuous spectra. The use of the photocell has added to speed and repetitive accuracy, but not to absolute accuracy.

The measuring of light sources giving a few lines only of the spectrum offers a very much more difficult problem which has been met by the use of sub-standard lamps and carefully selected and calibrated filters. However, with different colours errors creep in. Seeing is fundamentally a matter of contrasts in colour and in brightness, and it is these factors which should be measured. There are several methods of measuring brightness. Photography has been used for registering the effects of lighting on the human eye and recording them permanently on photographic plates. When the brightness of two contrasting surfaces has been measured, we still have no accepted methods of expressing them in terms of their aid to vision. Frichner's fraction, which is an approach in this direction, deals only with threshold values, and our interests lie in values far above those. The new technique of television offers an opportunity of controlling contrast. Details of the original picture and the reproduced picture at one stage are both held in terms of electrical energy and can be manipulated. With coloured light our problem is not merely to measure colour, but also to measure and specify colour and colour-rendering properties. The colour of light can readily be specified on the I.C.I. trichromatic system, and a rapid technique for indicating the colour of a light source directly on this system has recently been evolved. No standard has yet, however, been set up for the colour-rendering properties of light.

Devil's Dyke, Wheathampstead

THE presentation to the public of land at Wheathampstead, which has been made by Lord Brocket, chairman of the Hertfordshire Society of the Council for the Preservation of Rural England, as a personal gift commemorating the coronation of King George and Queen Elizabeth, preserves as an open space in perpetuity a site which, as has been shown by the excavations of Dr. R. E. Mortimer Wheeler, is of outstanding archæological and historical significance. For in addition to the four acres of the prehistoric earthwork, known locally as the Devil's Dyke, as Lord Brocket announced in handing over the 999 years' lease to the Wheathampstead Parish Council on October 23, the adjacent area of one hundred acres will also be preserved as an open space under an arrangement he proposes to make with the Hertfordshire County Council and the National Trust. It was here, Dr. Wheeler has shown, that there was situated the fortress, or *oppidum*, of more than a hundred acres in extent, the largest and strongest in Britain as yet known in its period, which was held by the Belgic tribes who had settled in Britain not long before, and of which the capture as the headquarters of the British forces was the climax of the campaign in the second of Cæsar's invasions of Britain; while almost immediately after that event, it would seem, it became the parent city of the British stronghold, also excavated by Dr. Wheeler, at Verulamium, which preceded the Roman occupation. The importance of the site for the history of pre-Roman Britain lays a debt of gratitude to the donor for his gift upon circles far wider than those immediately affected by its preservation of local amenities in the future development of the district.

Archæological Evidence and 'Development'

IT is unfortunately only too true that in many instances no private benefactor has been available, nor has public interest been sufficiently strong, to save relics of the past thought by many worthy of preservation, as the Wheathampstead site will be preserved. At the same time, land development and public improvement have not invariably run entirely counter to the interests of the archæologist. Not only have they brought to light antiquities of which the existence under the surface of the ground was unsuspected, but also on occasion they have made possible archæological investigations which otherwise it would probably have been impossible to undertake. The exploration of so large a site as that recently excavated at Colchester would have been difficult, if not definitely impossible, had it not been carried out in conjunction with the making of the new road. It is, however, not only the destruction of antiquities that is to be feared. Among other dangers there is the possibility of serious confusion of evidence which may follow the removal of archæological material from one area to another. An instance in point is mentioned by Mr. S. E. Winbolt in a communication to *The Times* of October 22, in which he records the discovery of a Roman house in the course of widening a road at Wiggonholt near Pulborough. The soil from this site is being transported by lorry to Pulborough Causeway, two and a half miles away. The discovery was made on the site of cottages called Lickfold (cabbage patch); and in the soil have been found fragments of Roman pottery, Samian and Castor, the foot-ring of a large Samian bowl, and a complete upperstone of a disk quern, fourteen inches in diameter, as well as a mortarium of first- to second-century type. Mr. Winbolt points out that future excavation on the Causeway, which is being widened on both sides, might bring to light Roman material from the Wiggonholt site, which would lead to quite erroneous conclusions as to the relation of the Causeway to Stane Street. Local societies might well be at pains to record any such shifting of material from sites within their respective areas.

British Museum (Natural History): Acquisitions

THE most important recent zoological accession to the Zoological Department of the British Museum (Natural History) is perhaps a collection of mammals and birds made by Messrs. Charles and Edward G. Bird in the Mygybukta region of North East Greenland. The collection is of special interest since it contains examples in breeding plumage and chicks of birds well known in the British Isles in winter, such as the knot, sanderling, turnstone and brent goose. There are also specimens of the ptarmigan in breeding plumage, as well as young birds and small ducklings of the king eider—a rare visitor to Britain. Among the mammals are specimens of the lemming, skulls and skeletons of arctic foxes, and various seals. Another important acquisition to the Department is the mounted head of a chobe situtunga (*Limnotragus spekei selousi*) presented by Major Henry Abel Smith. This rare antelope is known only from about a dozen specimens and enjoys a distribution to the south of the Zambesi between the Chobe Swamps and Lake Ngami in Bechuanaland. Among the accessions to the Department of Entomology is the very valuable collection of butterflies formed by Major P. P. Graves in the Near East, particularly in Palestine, Asia Minor, Syria, the southern Balkans and Greece. This collection is made up of more than 9,000 specimens, and is particularly rich in material from historic localities which were extensively worked by German and Austrian collectors in the middle of the last century.

The Department of Geology has recently acquired, through the generosity of Mrs. E. M. Reid, a valuable collection of fruits and seeds from the Pliocene of County Durham, Germany and Russia, most of which have been figured by her in the *Journal of Botany* and the *Quarterly Journal of the Geological Society*. In conjunction with M. P. Marty, Mrs. Reid has also presented nearly 700 fruits and seeds from the Pliocene of France. The Department of Botany has been presented with more than seven hundred drawings by the late Dr. A. H. Church. Most of the drawings were made in connexion with the preparation of further volumes of "Types of Floral Mechanism", of which only one volume, that of spring flowers, was published in 1908. A number of the drawings are in colour, but probably those which are of most interest are line and wash drawings of stages in the development of the different floral types. The drawings, accompanied by descriptions and manuscript notes, mostly ready for publication, are probably among the most accurate that have been made. The Department has also received about 900 gatherings of flowering plants and 400 gatherings of lichens and mosses which have been made by C. G. and E. G. Bird in the Mackenzie Bay area of the east coast of Greenland. The collection is well preserved and is valuable as coming from so far north. H. G. Vevers has collected about 500 numbers of flowering plants and cryptogams on the Oxford University Exploration Club's Faroes Biological Expedition. The Museum Herbarium has been so far very poor in plants from this area, and the collection, therefore, is the beginning towards filling an important gap, for many of the forms described appear to be very similar to some occurring in the British Isles, the land nearest to them.

North Pole Station

News from the Soviet North Pole Expedition is given by the Soviet Union Year Book Press Service. It would appear that the floating station is drifting southward towards north-east Greenland. This was to be expected from what is known of the general trend of Arctic currents. Under wind action there are easterly or westerly deviations from this main direction. The drift to the south has averaged 2·35 miles a day since the establishment of the station, and the speed is increasing as the East Greenland Current is approached. During the first month the drift to the south was 84 miles and during the fourth month it was 95 miles. A sounding in the vicinity of the Pole showed a depth of 2,346 fathoms, and it is unlikely that much greater depths occur in the Arctic Sea. The intermediate warm layer of water which Nansen discovered north of Spitsbergen and explained as being saline Atlantic water has been found near the Pole at depths between 12 and 30 fathoms. At a depth of 36 fathoms the water temperature was found to be almost zero, with a steady fall with increasing depth to $-0{\cdot}67°$ C. at the bottom. It is of interest to note that the inner parts of the Arctic Sea in the vicinity of the Pole are rich in plankton and have much larger animal life. The floes are even and flat. The smooth floes were, of course, reported by Peary, and did much to facilitate his march to the Pole.

The Indian Oil Industry

On the whole, the Indian oil industry figures less prominently in the general Press than that of other countries, notably the United States of America. The erroneous conclusion may, therefore, be drawn that methods of exploration, production and refining are not so far advanced in that country as in others. A recent paper by P. Evans (*Current Science*, 5, March 1937), however, clarifies this position by giving a succinct account of modern technique with particular reference to its application to conditions encountered in India and Burma. The main producing oil-fields are at Yenangyaung, Singu and Lanywa in Burma; Digboi in Assam; and Khaur in north-west India. Exhaustive geological mapping has been carried out over a vast area of India and Burma, and maps are available ranging in scale from 4 to 16 inches per mile. Numerous exploratory wells have been drilled, and the fact that the six leading companies in India have spent six crores of rupees on unsuccessful drilling indicates that neither time nor money has been spared in the search for new producing fields. Failure to locate such fields can in no circumstances be attributed to lack of scientific aid, for the help of the geophysicist and the geologist has been freely enlisted in India and Burma. The former has such adjuncts at his disposal as the torsion balance, seismograph, magnetometer and potentiometer; and the latter the aeroplane for field reconnaissance of large areas, the core-drill for putting down shallow-bores to check structure, and laboratory methods of palæontology, micro-palæontology and micro-petrology for the examination of core-samples.

In India, as in most other countries, the rotary drilling system is extensively used for all deep drilling, and such cognate problems as the best type of mud fluid to employ, the accurate diagnosis of strata traversed by the drill, and the prevention of crooked drilling have all been encountered and combatted scientifically by experts. Depths such as those attained in America have not yet been achieved in India, but there are records of wells drilled to more than a mile and a half, and in some cases very difficult territory has had to be negotiated. Though problems of optimum rate of production from individual wells and from fields as a whole are not absent in India and Burma, they are fortunately less acute than in some other countries. This is largely due to the fact that in India the mineral rights, with a few exceptions only, are vested in the State, and in several cases a field is worked by one company alone, while in Burma drilling is regulated by the warden of the oil-fields assisted by an advisory board. The principle of employing competent, fully-qualified geologists, chemists and engineers is followed in both India and Burma, and the technical literature now available as the result of exhaustive research and correlation of data from the results of past experience on the part both of the oil companies and of the Geological Survey of India is ample testimony of the progress made in the Indian oil industry since its inception.

Lister Institute of Preventive Medicine

AT the annual general meeting of the Lister Institute, held on June 2, the Governing Body presented the Institute's forty-third annual report. The report contains an interesting summary of the research work done during the year. Respecting viruses, a team of workers has continued the study of a possible virus agent in the causation of acute rheumatism and rheumatic diseases, Dr. Salaman has continued his investigation of the antigenic structure of vaccinia virus, and Sir John Ledingham has studied the peculiar relationship that exists between the filterable viruses of rabbit myxomatosis and rabbit fibroma. Dr. Felix and Miss Pitt have continued their investigations on the antigenic constitution of the typhoid bacillus, and on the virulence and immunizing properties of bacteria. Much work has also been carried out on vitamins and nutrition, and Prof. Robison has continued his studies on calcification. The two Svedberg ultracentrifuges, provided by a grant from the Rockefeller Foundation, have proved satisfactory, and have been used in the investigation of virus bodies and of proteins. The National Collection of Type Cultures, housed at the Institute, has distributed during the year some 5,000 cultures, and 200 new strains of micro-organisms have been added to the Collection.

The Night Sky in November

THE moon is new on November 3 at 4^h and full on November 18 at 8^h U.T. On November 20, the moon occults the 3rd magnitude star ζ Tauri, the disappearance as seen from Greenwich taking place at $5^h\ 33^m$ and the reappearance at $6^h\ 28^m$. On November 21, ν Geminorum (magnitude 4·1) is occulted, the reappearance being observable at Greenwich at $0^h\ 8^m$. Conjunctions of the moon with the planets occur as follows—Venus on November $1^d\ 8^h$: Jupiter on November $9^d\ 7^h$: Mars on November $9^d\ 21^h$: Saturn on November $14^d\ 16^h$. On November 4, Uranus is in opposition to the sun ; on this date the planet may be located between o Arietis and ω Arietis, stars of about the same apparent magnitude as that of Uranus, which presents a small disk of about $3\frac{1}{2}''$ in diameter. Both Jupiter and Mars are low in the early evening sky, but Saturn, southing at about 20^h in the middle of the month, is better placed for observation. Venus is a bright morning star and is near Spica (α Virginis) on November 6. The variable star Algol (β Persei) is well placed for observation throughout the night. The change in light may be easily seen about $1\frac{1}{2}$ hours before and after the following times : November $10^d\ 2{\cdot}2^h$, $12^d\ 23{\cdot}0^h$, $15^d\ 19{\cdot}8^h$ and $30^d\ 3{\cdot}9^h$. The Leonid meteors are expected between November 9 and 20, the radiant point being about 10° north of the bright star Regulus. The maximum of the Andromedids is due about November 20, the radiant being near γ Andromedæ. By midnight in mid-November, the brilliant collection of our winter stars comprising those of the constellation of Orion, preceded by Aldebaran and the Pleiades and followed by Procyon and Sirius, is well above the eastern horizon.

Announcements

DR. GÜNTHER JUST, director of the Institute of Genetics at the University of Greifswald, has been appointed director of the corresponding institute of the Health Office of the Reich at Berlin-Dahlem.

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 25, the following Council was elected : *President :* Sir D'Arcy Wentworth Thompson ; *Vice-Presidents* : Prof. F. A. E. Crew ; Lieut.-Colonel A. G. M'Kendrick ; Principal J. C. Smail ; Prof. J. Walton ; Dr. James Watt ; Prof. E. T. Whittaker ; *General Secretary :* Prof. James P. Kendall ; *Secretaries to Ordinary Meetings :* Dr. A. C. Aitken and Dr. C. H. O'Donoghue ; *Treasurer :* Dr. E. M. Wedderburn ; *Curator of Library and Museum :* Dr. Leonard Dobbin.

PROF. M. POLANYI writes with reference to his article on the recent international scientific meeting at the Palais de la Découverte (NATURE, Oct. 23, p. 710) : "In my article on the International Congress in Paris reference is made to a conversation with German delegates. This statement originates from an editorial correction of the manuscript. My own report stated that the remarks on a better understanding between German and French peoples were made at the opening meeting." Prof. Polanyi's original words, to the editorial modification of which he refers, were as follows : "Later in the evening I noticed a spy thrusting himself into my conversation with one of the German delegates. The German spoke about a better understanding of the German and French people—three delegates using the same, no doubt officially approved, phrase."

THE Oxford University Press announces that the treatise on the "Science of Petroleum", under the editorship of Dr. A. E. Dunstan, Prof. A. W. Nash, Sir Henry Tizard and Dr. Benjamin T. Brooks, will be published in December or January. It has been decided to issue the work in four volumes, instead of three, as previously announced. The preparation of a Supplementary Volume, with accounts of work which has appeared while the treatise has been in the press, is under consideration.

ERRATUM.—In the paragraph, based on Dr. J. Needham's Herbert Spencer Lecture, and entitled "Organization of Human Society", which appears in NATURE of October 16, p. 679, there is a sentence which reads : "He suggests that a democracy which produces is the form of society most in accord with what we know of the biological basis of human common life." The word "experts" should have been printed after the word "produces".

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 774.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Spontaneous Chromatin Rearrangements in *Drosophila*

SPONTANEOUS chromosomal rearrangements are considered to be rare in *Drosophila*. (Pale and blond are the known cases.) During the past few years I have found two new cases of considerable interest, the detailed analysis of which was delayed by external circumstances. Both cases occurred in pedigree and closely watched cultures, the abnormal broods being among numerous identical normal ones.

The first case started with an uncontrolled change of a standard plexus culture, which began to exhibit an extreme plexus character with blisters on one wing. It was found that here a 'mutation' to an allele of blistered had been added to the plexus stock. In studying some interesting peculiarities of this line, another change occurred. After this had happened, the plexus-blistered line was examined more closely, and it was found that the change to blistered had already entailed a rearrangement involving at least the additional loci white, echinus, rudimentary and extreme left end of the first chromosome. The new rearrangement resulted in the simultaneous appearance of the original plexus, of wild type, of rudimentary, identical with the classic one and of a recessive type 'mutant' with pointed wings, at the left end of the first chromosome. Also what seems to be an ebony allele appeared and a few less viable forms with spread plexus-blistered wings, or with only blisters. The analysis of the rather complex details is nearing completion.

The second case is still more remarkable. In one of numerous crosses of wild type and blistered a rearrangement occurred which involved, as it seems, only a second chromosome. This rearrangement produced simultaneously with the disappearing of blistered, the appearance of (1) dumpy, identical with the classic one; (2) vortex-thoraxate, the same; (3) purple, the same; (4) a plexus-like form still to be localized; and (5) a recessive 'mutant' with folded soft wings. Thus three well-known 'mutants', and possibly five, were produced as the result of an intra-chromosomal rearrangement.

It is remarkable that in both these cases the rearrangement hit a whole brood, thus indicating its occurrence in primordial germ cells.

These facts and others not yet ready for presentation, as well as the results of other workers, have convinced me—as repeatedly expressed in lectures within the past three years—that the time has come to acknowledge that gene mutations have as little existence as genes themselves. (A number of geneticists have already played with this idea, but hesitated to drop the old conception of the gene. They took refuge in position effects and mutations near the locus of a break.) The idea of a position effect, made to save the gene concept, will also have to disappear when it is recognized that the position effect is actually identical with what was called a gene. The chromosome as a unit will be found to control normal development or wild type. The changes of the correct order within its chain produce deviations from normal development, called mutants. Though they are localized, there is no such a thing as a gene and certainly no wild type allelomorph. Details will be published later.

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Ionization by Radioactive Gamma and Cosmic Rays in Different Gases

THE ionization by radioactive gamma and cosmic rays in different gases has been investigated by V. Masuch[1] since 1932 and by me since 1936[2]. For all measurements we used the same Kolhörster apparatus, the zero of which was separately determined at a depth of 406 m. in the Berlepsch salt mine of Stassfurt.

The effects of a radium C gamma ray source, filtered by 6 mm. of lead, of cosmic rays filtered by 5 cm. and 10 cm. of lead and of the penetrating radiation (unfiltered cosmic rays plus radium C gamma rays from soil and free air) gave the results shown in tho accompanying table.

	Density	Penetrating radiation	Cosmic rays		RaC γ-rays*	
			5 cm. lead filter	10 cm. lead filter	Our measurements	Ziemecki
He	0·0001787	0·50 *I*	0·30 *I*	0·26 *I*	1·00 *I*	
Ne	0890	2·40	1·29	1·27	4·25	
Ar	17629	4·89		2·45	8·51	7·55 *I*
Kr	3645	10·52	5·46	5·13	19·4	20·1
X	572	21·25	8·77	7·83	31·9	
H_2	008985	0·31		0·14	0·89	
N_2	12508					3·70
Air	12928	2·91		1·60	5·08	
O_2	14292	3·23	1·88	1·78	5·82	
CO_2	19768				8·70	

* On an arbitrary scale.

In Fig. 1 the ratio ionization/density is plotted as a function of the density of the gases concerned.

The ionization is directly proportional to the density of the gases only in the case of the hard components of the cosmic rays at sea-level. With softer components the curves bend more and more. The effect of ionization by radioactive gamma rays is therefore different from that by cosmic radiation at sea-level, so much so that this behaviour may be utilized in distinguishing between gamma and cosmic rays[3].

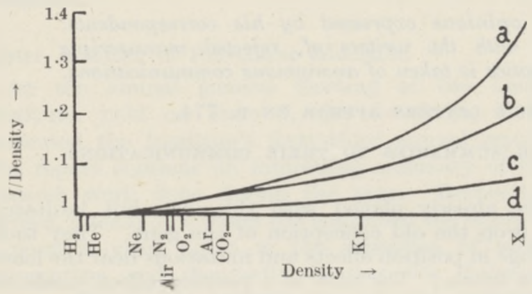

Fig. 1.

THE RATIO I/DENSITY PLOTTED AGAINST DENSITY. a, UNFILTERED PENETRATING RADIATION ; b, RADIUM C GAMMA RAYS FILTERED BY 6 MM. LEAD ; c, COSMIC RAYS FILTERED BY 5 CM. LEAD ; d, COSMIC RAYS FILTERED BY 10 CM. LEAD.

A short time ago Ziemecki[4] gave the following results for the ratio of ionization by radioactive gamma rays in nitrogen, argon and krypton to air :

$$I_{N_2} : I_{Ar} : I_{Kr} = 0{\cdot}49 : 1 : 2{\cdot}66 ;$$

while the densities are

$$\rho_{N_2} : \rho_{Ar} : \rho_{Kr} = 0{\cdot}77 : 1 : 2{\cdot}06.$$

These data for argon and krypton at 12 atm. agree with our results for one atmosphere ($I_{Ar} : I_{Kr} = 1 : 2{\cdot}28$) showing the same behaviour. However, Ziemecki believes the effects of ionization by gamma and cosmic rays to be roughly proportional. Our numerous measurements show only the hard components of the cosmic radiation at sea-level causing ionization in the ratio of the density of the gases examined.

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[1] Masuch, V., *Z. Phys.*, **79**, 264 (1932).
[2] Juilfs, J. and Masuch, V., *Z. Phys.*, **104**. 458 (1937).
[3] Juilfs, J., *Phys. Z.*, **38**. 691 (1937).
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Two Spectrometers for X-Ray Analysis

SOMETIMES a conical camera has been used to obtain good pictures of high-order layer-lines from a rotating crystal, the angle of the cone in most cases being about 60° or 90°.

In several respects this method is awkward. By making that angle 180°, the difficulties will be less ; the camera becomes more simple, the film easier to handle, and the identification of reflections will be more readily surveyed, every layer-line being a circle. Only the 0- and perhaps one or more of the lower order layer-lines will be missing on that photograph.

It is possible to take a photograph on a stationary film and on a moving film at the same time. Another possibility is to couple the movement of the film in some manner to that of the crystal, for example, by moving the film parallel to the crystal rotation axis (but not around that axis). In this way it will always be possible to assign the appropriate indexes to the spots on the film.

A simple camera design of this type is shown in Fig. 1 ; a circular stationary film, a ; another film at the same distance from the crystal, but rotating with the crystal, b ; whereas the 0-layer-line is recorded on a narrow cylindrical film, c.

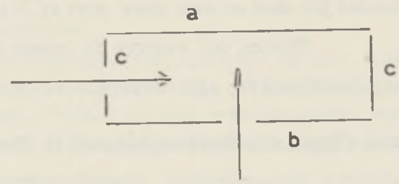

Fig. 1.

For the investigation of powders it may be advantageous to use a camera with the film cylinder having the same axis as the X-ray beam (see Fig. 2). The reflected beams, lying on cones, will cut the cylindrical film in circles ; when spreading out the film after developing, the picture of straight lines will resemble a diagram taken with an ordinary optical spectrograph. Especially for purposes of identification, as well as for back-reflection X-ray

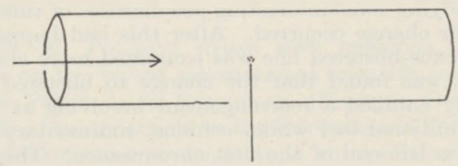

Fig. 2.

photographs, the method described may be useful. Taking a series of exposures on the same film, a narrow strip may be taken parallel to the primary beam. In that case a flat film or plate can be used.

I am indebted to Prof. Ir. J. A. Grutterink, who enabled me to design the cameras described.

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Spacing of the Resonance Neutron Levels of Silver, Rhodium and Bromine Nuclei

FROM recent work on group and thermal neutrons[1], the constants describing the resonance absorption of an element can be calculated fairly accurately. This simplifies the estimation of the average spacing of the resonance neutron levels in the experiment of Chao and Fu[2] and makes it possible to work with a thinner paraffin scatterer so as to obtain a beam of neutrons distributed more uniformly over the energy spectrum. We have now made measurements with a paraffin scatterer of only 2 mm. thickness. The neutron source consisted of 100 mgm. radium surrounded with 12 gm. beryllium, and the scatterer in the form of a spherical shell was of 4 cm. outer diameter. Detectors of silver, rhodium and bromine, approximately 3 cm. × 3 cm. in size, were exposed at a distance of 1·2 cm. from the paraffin, and the induced activity was measured with a Geiger-Müller counter.

Let the neutron capture cross-section due to the existence of a single resonance level be written as

$$\sigma = \frac{A}{E^{1/2}\{\Gamma^2 + (E - E_r)^2\}},$$

where E_r and 2Γ are the energy and half width of the level, both to be expressed in volts. Then the ratio of the capture cross-sections of the resonance and thermal neutrons with self induction is given by

$$\sigma_g : \sigma_c = \frac{A}{2E_r^{1/2}\Gamma^2} : \frac{A\pi^{1/2}}{(0{\cdot}026)^{1/2}E_r^2} = \frac{(0{\cdot}026)^{1/2}E_r^{3/2}}{2\pi^{1/2}\Gamma^2}.$$

This formula when applied to the capture cross-sections of the group and thermal neutrons, should give an approximate value of Γ and hence of A, except in the case where the first negative resonance level is closer to zero energy than the first positive level (as might be the case of bromine).

Let E_0 be the upper limit of the continuous spectrum of the neutrons scattered from paraffin, N_0 the number of scattered neutrons received by the detector per volt energy range and per second, μ the absorption coefficient of the β-rays per atom of the detector, and n_1 the average density of the resonance levels per volt. Assuming Γ and A to be constant for the resonance levels located in the continuous neutron spectrum, we can easily deduce the following approximate expression[3] for the total number of β-rays given in one second by a thick detector in the saturation state:

$$\Sigma N = \frac{N_0 \pi A n_1 E_0^{1/2}}{\mu\Gamma}.$$

To calculate N_0, we make the photo-electric cross-section of beryllium nuclei equal to 2×10^{-28} cm.^{2}, the proton-neutron scattering cross-section equal to 10×10^{-24} cm.^{2} and E_0 equal to $1{\cdot}42 \times 10^5$ v. Knowing Γ, A, E_0 and N_0, we can evaluate n_1 from the measured values of μ and ΣN. Various quantities used in our calculation are collected in the following table, where column $\triangle$ gives the average spacing of the resonance levels, all referring to the short period. For Ag, the second value is obtained with a thin detector of surface density 0·06 gm./cm.^{2}.

	$\sigma_g \times 10^{24}$	$\sigma_c \times 10^{24}$	E_r	Γ	$A \times 10^{24}$	$\mu \times 10^{24}$	$N_0 \times 10^3$	ΣN	$\triangle (= 1/n_1)$
Ag	3560	535	2·5	0·052	30·5	1000	2·5	0·355	5
Ag								0·133	4
Rh	680	102	1·2	0·095	13·5	1000	2·0	0·373	0·9
Br*	740	7·3	62	0·42	2050	1200	2·1	0·184	55

*Neutron absorption coefficients of this element determined by T. H. Wang.

The values of $\triangle$ here obtained are seen to be in good conformity with the location of the ordinary neutron groups. It is, however, to be noted that the present calculation is based on various cross-sections which are only known approximately, and it can be further improved when the accuracy of these quantities attains a higher degree.

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[1] Amaldi and Fermi, *Phys. Rev.*, **50**, 899 (1936); Goldsmith and Rasetti, *Phys. Rev.*, **50**, 328 (1936); Breit and Wigner, *Phys. Rev.*, **49**, 519 (1936); Bethe and Placzek, *Phys. Rev.*, **51**, 450 (1937).

[2] Chao and Fu, *Chinese J. of Phys.*, **2**, 135 (1936); NATURE, **139**, 325 (1937).

[3] This formula can be obtained from formula (12) of the paper in *Chinese J. of Phys.* by neglecting the long factor.

Changes of Colour by Injection of Pituitary Extracts in a Dogfish (*Scylliorhinus canicula*)

INJECTIONS of pituitary extract were performed on an exceptionally light-coloured dogfish obtained in the Aquarium at Dinard in August 1937; in this fish the usual large patches were very faint, and so were the small spots or maculæ. At a distance of ten yards from the tank, the lack of colour of the integument made the animal very easily distinguishable from its fellows. The condition could not properly be described as albinism, the pigment not being altogether lacking: apart from a certain amount of pigment, faintly but evenly extending over the whole of the back, there was a dark spot, about one third of an inch in diameter, behind and above the right gills. With the exception of the pallor of the skin, this male fish was quite similar to the others in size and shape.

The extract used (Post-hypophyse Choay No. 4) contained half of the posterior lobe of ox-pituitary per c.c. and the injections were made intraperitoneally.

RESULTS

The first injection (0·25 c.c.) was without apparent effect.

The second injection (0·7 c.c.) caused the following changes: 15 minutes after—a slight darkening of the skin; 30 minutes after—a very distinct darkening: the patches appeared sharply, the spots became darker, the fish could only be distinguished from the others by a mark made on the fin, its colour being as dark as that of the nine or ten normal fish in the tank; 3 hours after—condition unchanged; 18 hours after—the fish had almost resumed its original whitish colour.

The third injection (1 c.c.) gave exactly the same results.

A control injection was then given of 1 c.c. of sea-water: it did not influence the colouring in the least.

The fourth injection of the same pituitary extract was then made (1 c.c.). The darkening was as great as before, but lasted only about three hours.

A fifth similar injection (1 c.c.) produced darkening which lasted twenty to twenty-two hours.

At that stage an injection of *anterior lobe* of pituitary was tried (0·5 c.c.) of an extract containing 0·25 gm. of gland per c.c. (Zoo-Antelobyl Roussel). It gave no results.

An injection of another brand of *posterior lobe* extract (Zoo-Postlobyl Roussel) containing 5 International Units per c.c. was given and the results were:

First injection (0·5 c.c.) (2·5 International Units)—10 minutes after—the fish was getting darker; 30 minutes after—the fish became indistinguishable from the others in the tank; 3 hours after—original colour nearly restored.

Second injection (1 c.c.): Same results but more lasting (12 hours).

Forty-eight hours after this last injection, the fish died, without having quite resumed its original colour: possibly the last dose of hormone had been too great.

A constant reaction to all the injections of posterior lobe extracts, especially at the beginning of the absorption period, was an increase in the rate of breathing: 70-80 respirations per minute, instead of 50-60 normally.

The post-mortem examination showed, first of all, that a severe wound which the fish had received from a metal fitting in the tank, four or five days previously, had left a fairly deep cavity filled with blood-clot, completely destroying the right spiracle and surrounding area.

The organs seemed to be quite normal except the gall-bladder, which had apparently been perforated by the injection needle.

The base of the brain revealed a peculiar type of pituitary body. The ventral, nervous lobe, with its connecting stalk and infundibulum, seemed slightly smaller than usual in this fish; the vascular body (situated dorsally to the nervous lobe, between it and the brain) was smaller than usual, displaced laterally and seemed to be grafted on to the right angle of the optic chiasma. In the normal fish, the two lobes are in contact, but can easily be separated. In this one the gap was evident.

Histologically, both lobes appeared normal, but in the vascular body chromophobe cells tended to prevail.

No trace of traumatic lesion of the roof of the mouth was found, and the aspect of the gland seemed to point to a congenital condition.

The congenital malformation of the gland might explain the insufficiency of the pigmentary system merely by lack of its development, or perhaps the gap between the two lobes prevented proper circulation between them.

The fish reacted to the posterior pituitary extract in the same way as the hypophysectomized fish, as observed in successful operations performed on normal dogfish during the course of injections mentioned.

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Self-arrangement in the Mitotic Spindle under Mechanical Influence

IN a previous communication[1] it was pointed out that in all types of protoplasm hitherto used, fibrils or linear units are really present, although only visible if the protoplasm is flowing through the capillary of a deformation apparatus.

The following are more recent observations concerning the appearance of the mitotic spindle fibres after *mechanical* gelation of the anaphasic nucleus. No traces of spindle fibres are to be seen at any stage of mitosis in living connective tissue cells cultivated *in vitro* under the usual conditions[2]. But they become visible as soon as acid is added (M. R. Lewis), or when a similar gelation is brought about by means of a gentle rapping or pressure of the culture (J. Ellenhorn[3] on living cells of *Tradescantia*), or by a stretching of the jelly film of the culture spread out within a little glass frame (H. H. Pfeiffer). All recent evidence supports the view that the spindle is a comparatively rigid structure. Experiments of R. Chambers show quite clearly that it is like an *elastic gel* capable of considerable mechanical distortion.

It is generally assumed that the energy for movement of the daughter chromosomes towards the poles is derived either from the spindle, the fibres of which are looked upon as contractile fibrillæ (*Zugfasern*), or from a body driving asunder the chromosomes (*Stemmkörper*). The spindle fibres have been proved to exist as positively doubly refractive bodies between crossed nicols[4]. Such a phenomenon cannot occur except by a flowing or pulling process. Therefore, W. J. Schmidt supports the hypothesis of contractile pulling, and compares the spindle fibres with other contractile fibrillæ of protein nature showing positive double refraction[5]. This comparison, however, may not be valid, because the anaphasic chromosomes moving towards the pole intersect the spindle fibres in spite of their rigidity. From observations between crossed nicols it seems correct to conclude that the spindle fibres arise in a similar way to Zocher's tactoids[6]. In the geloid stage of the mitotic nucleus the anisotropic particles may approach each other owing to a dehydration process, but the contractibility of the fibres does not explain the mechanism of the movement of chromosomes.

From a theoretical point of view, there is a number of interesting problems involved in the physics of a dividing cell nucleus, and I hope to give a detailed communication of my experiments at the Fifth International Congress for Experimental Cytology at Zurich. At present I wish to show that, owing to a weak mechanical influence, in the nucleus of mesenchyme cells of *Salamander* embryos cultivated *in vitro*, distinct spindle fibres with positive double refraction arise and give further evidence for anisotropic and linear structure within the cell.

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[1] Pfeiffer, H. H., NATURE, 138, 1054 (1936); *Cytologia*, Fujii Jubil. vol. (1937); *Verh. deutsch. zool. Ges. Bremen*, 106 (1937).

[2] Fischer, Alb., "Gewebezüchtung", 3. Aufl. (München: R. Müller u. Steinicke, 1930); Levi, G., *Erg. Anat. u. Entwgesch.*, 31, 125, 316 sq. (1934).

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[5] Schmidt, W. J., "Die Doppelbrechung von Karyoplasma, Zytoplasma und Metaplasma", p. 121 sq., 251 (Berlin: Gebr. Borntraeger, 1937).

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Interaction between Cell Nucleus and Cytoplasm

THE assumption has been made frequently that the genes exert their effects upon the cytoplasm during the 'resting' stage of the cell. This implies that nuclear end products of genic reactions can pass through the nuclear membrane or at least react with cytoplasmatic components at the nucleo cytoplasmatic interphase. However, no explicit demonstration of this assumption has been given as yet. On the other hand, it has been proposed, again without proof, that the genic end-products in the nucleus are released into the cytoplasm during the mitotic breakdown of the nuclear membrane only.

It is the purpose of this note to indicate that the two opposing views can be tested and that data are available for a decision. If the genetic constitution of a cell is changed, and if a cytoplasmatic effect of the new constitution becomes apparent in this single cell before nuclear division has occurred, it is obvious that the gene concerned has interacted with the cytoplasm during the resting state of the nucleus. If, on the other hand, the cytoplasmatic effect of a changed genetic constitution becomes visible only after nuclear division and in the two ensuing daughter cells, then the conclusion is suggested that the disappearance of the nuclear membrane is necessary for the release of the gene-dependent substances. Changes in genetic constitution occur in somatic tissues as the result of mutations or of chromosomal processes like segregation, non-disjunction, etc.; and in germ cells as the result of recombination of genes during the maturation divisions.

An analysis of the few cases in which genetically determined characters can be observed in single cells, in *Delphinium*, *Zea Mays*, the smut fungus *Ustilago* and *Chlamydomonas*, indicates that specific genes can interact with the cytoplasm during the resting state of the nucleus. These genes are concerned in the production of anthocyanes, of specific sexual reactions, and of different morphological characteristics. Further work undoubtedly will increase the number of known cases. It remains to be seen whether examples will be found in which gene-controlled substances exert visible effects after the breakdown of the membrane only, as is possible in some cases of pollen dimorphism.

A more complete discussion of the data will appear in the *American Naturalist*.

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Action of Pancreatic Extract on Fatty Liver

Kaplan and Chaikoff[1] have shown that the fatty infiltration of the liver in depancreatized insulin-treated dogs can be inhibited by the addition of raw pancreas to the usual diet. Dragstedt[2] and his co-workers then showed that the active factor can be extracted from pancreas by the aid of alcohol. In conjunction with these investigations, we sought to answer the following two questions: (1) whether in normal rats the fat content of the liver can be influenced by a diet of pancreas; and (2) whether a variation in the fat content of the liver is linked with a variation of the carbohydrate content.

Pancreatic extracts were prepared by a method almost identical with that of Dragstedt. Each rat received a quantity of extract per week corresponding to 100–150 gm. of fresh pancreatic tissue.

In normal fed rats (20 per cent casein, 70 per cent starch, 10 per cent fat), no definite differences in the fat content of the liver were evident when the pancreatic extract was added to the diet. When, however, a fatty liver had been produced by diet, an average decrease from 12·8 per cent liver fat content to 5·2 per cent was obtained by administration of pancreatic substance in fourteen experiments. The nutrition period lasted 6–14 days and in two cases 30 days. The diet was as follows: saccharose 45 per cent, butter fat 40 per cent, casein 5 per cent, marmite 5 per cent, salt mixture 5 per cent (Channon[3]).

Extracts of spleen, brain or liver prepared in exactly the same fashion and fed in the same manner were generally without effect or very much weaker (liver) than those of pancreas. No uniform differences in fat and sugar content of the blood or in the excretion of total acetone bodies were observed as between control rats and rats treated with extract. If the quantity of acetone bodies is assumed to be a measure of fatty acid oxidation, it must be concluded that the pancreatic extract under consideration is without effect on fat oxidation. This conclusion is supported by the fact that in the two experiments of longest duration, no less body fat was found in rats treated with pancreatic substance than in the control animals. The weights in the treated animals were in general better maintained than in the controls.

As regards the second question, it can be stated that in conjunction with the decrease of fat content of the liver of treated animals no increase of glycogen content could be established in our brief experiments, so that for our conditions at all events the antagonism between fat and glycogen in the liver does not exist. Experiments in this connexion extending over longer periods will be reported later.

It is clear that the rat method possesses great advantages in the investigation of the pancreatic substance. This substance could not be demonstrated in the outer medium after extended dialysis through parchment membranes. Positive results could be obtained, however, after a brief period of dialysis through 'Cellophane' and cuprophane. A strongly positive effect is obtained with pancreas autolysate. It is not quite clear as yet, however, if this effect is absolutely specific. The question whether the active principle in pancreas is choline (Best) has to be clarified. The fact that the quantity of choline necessary according to Best could not have been contained in the quantities of extract fed by us is against this conclusion, as is also the ineffectiveness of extracts of the other organs mentioned. Moreover, choline is adsorbed by Lloyds reagent and can be eluted by barium hydroxide. These tests failed with the pancreatic substance under consideration.

After the experiments here reported had been concluded, a paper was published by Eaton M. MacKay[4], in which the rat method for the demonstration of the action of pancreas on liver fat was used. His results are consistent with ours.

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Specific Action of Ferricyanide on Ærobic Glycolysis of Tumour Cells

It has been found[1] that ferricyanide (10^{-2} mol./litre) stops *ærobic* glycolysis of mammalian tumour cells, but it does not affect *anærobic* glycolysis of any cell in mammals. In this respect, ferricyanide differs fundamentally from all other substances which have been found to check glycolysis (fluoride[2], monoiodoacetic acid[3], glyceric aldehyde[4]).

Ferricyanide is reduced by tumour cells, probably combining with and inactivating some part of their glycolytic system. The action of ferricyanide outlasts the time of its application: tumour cells once deprived of their ærobic glycolysis by ferricyanide do not glycolyse ærobically for many hours if kept in a medium no longer containing ferricyanide.

In order to find out whether the action of ferricyanide would be restricted to glycolysis of tumour cells and thus be specific, experiments were done with medulla of kidney, which has been found[5,6] to be the only normal mammalian tissue with ærobic glycolysis. Rat, cat and guinea pig kidneys were used. In no case did ferricyanide check the ærobic glycolysis of kidney medulla; in some experiments ærobic glycolysis was even stimulated slightly by ferricyanide. Glyceric aldehyde, on the other hand, was found to inhibit both ærobic and anærobic glycolysis in kidney medulla as it does in tumours[4].

These experiments (see Tables 1 and 2) were carried out with O. Warburg's manometric method[7], the results being controlled by chemical determination of lactic acid[8].

POTASSIUM FERRICYANIDE

	Mol./litre	$Q^{O_2}_{CO_2}$	$Q^{N_2}_{CO_2}$
Medulla of kidney (rat)	0 10^{-3}	10·5 12·8	28·7 29·5
do. (rat)	0 10^{-3}	11·7 12·4	26·6 26·2
do. (cat)	0 10^{-3}	15·7 16·1	
do. (guinea pig)	0 10^{-3}	14·2 15·3	19·7 20·5
Balogh tumour (mouse)	0 10^{-3}	22·1 2·3	28·9 27·5

d,l-GLYCERIC ALDEHYDE

	Mol./litre	$Q^{O_2}_{CO_2}$	$Q^{N_2}_{CO_2}$
Medulla of kidney (cat)	0 2×10^{-3}		14·6 1·9
do. (rat)	0 4×10^{-3}	14·2 2·3	
Balogh tumour (mouse)	0 2×10^{-3} 4×10^{-3}	19·9 3·7	32·3 2·8

Ferricyanide thus seems to act exclusively and specifically on ærobic glycolysis of mammalian tumour cells.

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Œstrogenic Activity of some Hydrocarbon Derivatives of Ethylene

IN an earlier preliminary communication[1], we reported the activity of some substituted derivatives of ethylene including the hydrocarbon diphenyl ethylene (stilbene). Before making any further publication, we decided to investigate other hydrocarbons of the same series as extensively as possible. Robson and Schönberg[2], however, have since reported the activity of triphenyl ethylene, and as these workers made no reference to the communication in which we initiated this series of œstrogenic substances we feel that the full publication of the series now completed will be of interest. The following table shows our results.

Substance	Dose (mgm.)	Percentage Positive
Styrene	100	Nil
Propenyl benzene	100	Nil
Stilbene	25	100
α : α-Diphenyl ethylene	100	Nil
Triphenyl ethylene	10	100
	5	50
Tetraphenyl ethylene	25	Nil
α : β-Di-1-naphthyl ethylene	25	Nil
α-Methyl stilbene	25	Nil
α : γ-Diphenyl propylene	25	Nil
β-Methyl-α : γ-diphenyl propylene	25	Nil
α : δ-Diphenyl butadiene	25	100

The long duration of œstrus and the induction of mating are usually associated with this type of compound. Working with substances supplied by us, Hemmingsen and Krarup[3] have demonstrated mating instincts of high degree in the ovariectomized rat and enhanced spontaneous muscular activity, whilst Wolfe[4] has shown that our substances are capable of preventing the development of castration cells in the anterior lobe of the pituitary.

E. C. DODDS.
M. E. H. FITZGERALD.
WILFRID LAWSON.

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Middlesex Hospital, W.1.
Oct. 13.

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Dust Control in Industry

IN a recent letter[1] Prof. H. V. A. Briscoe and collaborators report on some work done in connexion with the solubility of quartz and other dusts. Speculating on the practical indications of their results, they suggest that "admixture of a dust such as that of fresh cement . . . might well serve to mitigate the effects of dangerous (that is, silicosis-producing) dusts".

While the suggestion is not sufficiently concrete to afford ground for a fruitful discussion, we are nevertheless curious to learn whether the authors contemplate the possibility of entirely supplanting present unproblematical methods of silicosis prevention by others involving the increase of industrial dust concentrations. We venture the following trivial, but apposite, remarks.

The known positive method of preventing the onset of silicosis among those engaged in dusty trades is to remove the dust from the air they breathe. This can be accomplished either by obliging all persons working in a dusty atmosphere to wear adequate filter masks, air-supplied respirators and the like, or to suppress the dust itself. The former method, although cheaper, possesses many obvious disadvantages, including the difficulty of enforcement, and should be superseded wherever practicable by the latter. Of course, the reduction of dust concentrations to an absolute zero is impossible, for both engineering and economic reasons. Fortunately, however, in a great majority of cases their reduction to a hygienically satisfactory level is quite feasible. In fact, it is safe to say that if funds and engineering talent were as readily available for dust suppression as a health measure as they are when it becomes a question of protecting an article in process of manufacture from injury by dust, silicosis would soon be of historical interest only.

The procedures are well known : essentially they consist in the control of dust at its sources by means of properly designed and adequately ventilated hoods and enclosures. The expenditures involved are moderately high, but not inordinately so when comparison is made with the annual costs of silicosis compensation, or with the benefits to be achieved. These benefits include, besides the safeguarding of health, many of an intangible but none the less real nature. Almost invariably the brighter and cleaner conditions which follow a serious programme of dust elimination are reflected in increased interest and efficiency on the part of the workers. Fundamentally, dust is an asset in no industry : we have yet to meet the plant manager, however resistant to the invasion of new and expensive ideas, who would assert that it was. Less, not more, dust is desirable from every point of view.

For a number of years public health authorities, insurance companies and similar bodies have been waging an active campaign aiming at the suppression of dust in industry. They have been met half-way by the more progressive sections of industry. The advocacy, in other quarters, of an opposite policy might, however, seriously retard the campaign among the laggards.

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L. B. Leppard.
Engineers,

Division of Industrial Hygiene,
Ontario Department of Health,
Toronto.
Sept 2.

Having been invited to comment on the foregoing letter, I would first say that I am entirely in sympathy with its main thesis : a plea for the suppression of dangerous dusts by all known means. Unfortunately the authors' enthusiasm for dust suppression leads them to damage a perfectly sound case by overstatement. They seem, indeed, almost to imply that silicosis can be so completely and satisfactorily prevented by masks and ventilation that the investigation of its cause and cure is superfluous.

There are numerous cases, typically in mining and quarrying, where the suppression of dust to anything approaching a safe level is extremely difficult. Moreover, as the authors admit, "the reduction of dust concentrations to absolute zero is impossible", and the whole tendency of our recent work is to show that the finest fraction of active dusts, which is the most difficult to suppress, is by far the most dangerous. It is possible, therefore, that reasonably good ventilation, and still more the wearing of masks, may give a false sense of security.

In these circumstances I am unrepentantly keen to find out why dangerous dusts are dangerous. The fact that some dusts are safe, in the sense that they quite certainly do not cause silicosis even where workers are continuously subjected to relatively high concentrations, is clear proof that the dangerous dusts must differ from them in kind and possess certain chemical properties wherein their danger lies. Knowing what I know, I would cheerfully work for years in cement dust at a concentration of 10 or 20 mgm. per cubic metre, but I would not willingly work a month in flint or felspar dust of one tenth that concentration.

It seems obvious, therefore, that it is likely to be advantageous to add to a dangerous dust any material, solid, liquid or gaseous, which can be proved to eliminate or even to minimize its dangerous properties. Whether the total concentration of dust is thereby increased is a point of quite minor importance.

Our general findings in the matter of active dusts[2] have speedily been confirmed by the very interesting results recently published by certain Canadian workers[3], who have not only succeeded, where others have failed, in producing silicosis in small animals by subjecting them to freshly produced (live) dangerous dusts but also have shown that the addition of aluminium powder to these dusts makes them much less liable to produce silicosis.

While I respectfully differ from these workers in holding that much remains to be done before any definite recommendation may properly be made about preventive measures, it is, in my view, now proved that the study of the *qualitative* properties of dusts will yield valuable results, and we must be prepared, in due time, to follow without prejudice wherever the new knowledge may lead.

H. V. A. Briscoe.

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and Technology,
London, S.W.7.
Oct. 6.

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Designation of "the Time-Space Continuum"

Cumbrous language is the enemy of thought. If, as seems likely, the above quadri-verbal septapedalion vocable is to remain a centre of interest and discussion, it needs a handy name.

To this end let authorities bend their fancy and devise a crisp word symbol for the thought. Could this be on the agenda of any learned society ? I doubt it. It is the normal job of mathematicians to decree that a simple symbol shall represent a complex ; for they know well the advantage of this procedure. Shall the ordinary man be deprived of similar aids ?

The new name would no longer need to be wedded to the indicative article 'the'. Just as we say 'time' or 'space' we would say, *not* 'the time-space continuum' but 'tispacon', or 'espatem', or whatever the name is. My own leaning is for 'spatecon' ; but no matter what the word is so it be short.

Mervyn O'Gorman.

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Sept. 18.

Hyperbolic Space

In Nature of October 9, 1937, under the heading 'Red shifts and the Distribution of the Nebulæ", there is repeated a statement of Dr. Hubble's to the effect that hyperbolic space of negative curvature leads to a distance-distribution of nebulæ which is contrary to observation. It is, however, well known that the distances of nebulæ are in no sense 'observed': they are defined by means of theoretical formulæ in terms of the observed apparent magnitudes of the nebulæ. Moreover, the definitions vary with the process of distance-measurement envisaged. Dr. Hubble's statement is, therefore, only true if (*a*) we accept his particular definition of distance in terms of apparent photographic magnitude, and if (*b*) we also accept his identification of this distance with a certain one of the quantities figuring as 'distance' in the model universes of general relativity.

In a detailed investigation, to appear shortly in the *Zeitschrift für Astrophysik*, I have shown that, by retaining (*a*) and rejecting (*b*), all Dr. Hubble's observational formulæ are in complete accord with a hyperbolic space of infinite extent. His two alternatives, namely, that we must abandon either the homogeneity of the nebular distribution or the expansion of the universe in order to obtain a satisfactory interpretation of the data, do not, therefore, exhaust the possibilities. Both homogeneity and expansion may be retained provided that we modify Dr. Hubble's theory of 'distance'.

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A Cosmic Ray Burst at a Depth equivalent to 800 m. of Water

UNDER the above title we announced in NATURE[1] the results of our measurements in a railway tunnel, in which we observed a burst of the size of about 10^7 ions at an equivalent depth of more than 800 m. of water. In the note, however, we regret to have made the following statement, which we should like here to withdraw :

"Both Kolhörster and Corlin[2] made measurements with an ionization chamber down to 800 m. water-equivalent underground. The cosmic ray intensity at this point was tentatively assumed to be zero. From the above results, however, we see that there still remains a very small part even at this depth."

The fact is that Kolhörster[2] published, contrary to our statement, the results of his underground measurements by means of the coincidence method, which is independent of any residual ionization.

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C. ISHII.

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Institute of Physical and Chemical Research,
Tokyo.
Sept. 24.

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Points from Foregoing Letters

PROF. R. GOLDSCHMIDT describes two cases of spontaneous mutations in *Drosophila* cultures in which three well-known mutants, and possibly five, were produced by intra-chromosomal rearrangement. The observed mutations, the author states, do not agree with the theory postulating the existence of genes or gene mutations ; he would explain mutations as due to changes in the 'correct order' within the chromosome chain, without attaching particular characters to special regions of the chromosome.

A table and graph comparing the ionization produced in various gases by cosmic rays and by gamma rays from radium C, are submitted by J. Juilfs. The ionization is directly proportional to the density of the gases only in the case of the more penetrating cosmic rays, and this fact may serve to distinguish between such cosmic rays and the less penetrating gamma rays.

Two simple camera designs, for X-ray spectrum analysis, are described by W. F. de Jong, who points out a number of advantages resulting from the use of a cylindrical in place of a conical camera.

Using a thin (2 mm.) paraffin layer as 'scatterer' so as to obtain a beam of neutrons distributed more uniformly over the energy spectrum, C. Y. Chao and T. H. Wang have measured the induced radioactivity in silver, rhodium and bromine. Accepting certain approximate values for the cross-sections of their nuclei, the authors calculate the spacing of the resonance neutron levels in the nuclei of those three elements.

Changes in colour produced in a light-coloured dog-fish by injection of pituitary extract are described in detail by D. R. Barry.

Dr. H. H. Pfeiffer discusses the possible nature of the forces acting on chromosomes during mitotic division, and states that in the case of the nucleus of mesenchyme cells of *Salamander* embryos, cultivated *in vitro*, distinct spindle fibres with positive double refraction arise through the action of a weak mechanical influence on the protoplasm.

Prof. C. Stern suggests a method by means of which it may be decided whether or not end products of genic reactions within the nucleus can exert an influence upon the cytoplasm prior to the breakdown of the nuclear membrane at mitosis.

B. Shapiro and Prof. E. Wertheimer state that, in the rat, excessive liver fat of nutritional origin can be removed by administration of alcoholic extract of pancreas. The treatment does not lessen the body fat, does not increase the acetone body excretion in the urine and does not change the quantity of fat or sugar in the blood. No antagonism between liver fat and liver glycogen was found in these experiments. The effective principle seems to be specific to pancreas.

Further experiments by Dr. B. Mendel and Miss F. Strelitz show that potassium ferricyanide, which stops the transformation of glucose into lactic acid (glycolysis) in the presence of air by tumours, does not prevent this process from taking place in kidneys ; the inhibitive effect of the ferricyanide appears to be specific for tumours.

A number of ethylene derivatives have been tested for œstrogenic activity by Prof. E. C. Dodds, M. E. H. Fitzgerald and W. Lawson. In addition to stilbene and triphenyl ethylene, diphenyl-butadiene has been found to affect the mating instincts of rats from which the ovaries had been removed.

Dr. G. C. McVittie points out that the distribution of spiral nebulæ can be interpreted in terms of hyperbolic space provided that some modifications are made in Dr. Hubble's theory of distance.

Research Items

Palæolithic Succession in England

MR. T. T. PATERSON has inaugurated a study of the palæolithic succession in England with an examination of finds at Barnham St. Gregory (*Proc. Prehist. Soc.*, 3, 1 ; 1937). This site, a pit from which brick-earth has been dug, is situated in a small shallow valley running parallel to the Little Ouse near Cambridge. It was discovered in 1933, but implements had been found there previously on several occasions in the brick-earth. The implements now under consideration are found in the gravels and sands, with intercalated beds of clay and silt, in all more than sixty-four feet deep, which underlie the brick-earth. *Coups de poing* were found in the brick-earth, three feet above the gravel surface. In the implements, six industries, five from the gravels, are distinguished by geological horizon, state of wear and platination, and typology. Industry *A*, the earliest, is heavily rolled and battered and deeply patinated. It is found at depth in the gravels, whereas the others are confined to the top layer. These latter are distinguishable by their depth in the gravel and their patination and wear. Both *A* and *B* have suffered from the effects of solufluxion. The sixth industry comes from the brick-earth and is essentially Acheulean, whereas the earlier gravel industries are flake implements. More than 1,500 implements have been taken from the pit, apart from those of tabular flint and rejects. Here then at Barnham is a series of industries showing progressive development along indigenous lines uncontaminated by contact with other cultural techniques. It belongs neither to Clactonian nor proto-Levalloisean ; and it is suggested that it be called the Barnham sequence of the Clactonian.

Origin of Tuberculosis and Nature of the Tubercle Bacillus

TUBERCULOSIS in man and animals is almost universally regarded as being caused by infection with a parasitic bacterium, the tubercle bacillus. Prof. J. Tissot, professor of general physiology in the Muséum national d'Histoire Naturelle, Paris, combats this view in an elaborate histological study of tuberculous tissues ("Constitution des Organismes, Animaux et Végétaux : Causes des Maladies qui les Atteignent". Vol. 2, Cause et Nature de la Tuberculose. Paris, at the Muséum, 7 Rue Cuvier : 1936). He maintains that the tubercle bacillus is not a rod-shaped organism (bacterium), but is a dumb-bell-shaped structure derived from embryonic cells in the tuberculous nodules. Tubercle bacilli, according to his view, are the mitochondria of these cells, and so-called cultures of tubercle bacilli are in reality cultures of these mitochondria. Prof. Tissot believes that he has established the fact that tuberculosis develops spontaneously in the individual, and is not usually the result of contagion. He does, however, speak of the 'tuberculous mitochondria' as being a *virus*, and it is not clear from his monograph in what manner he considers cultures of the so-called tubercle bacillus of the bacteriologist act in inducing tuberculosis, as they certainly do, when inoculated into a susceptible animal.

Embryology of the Ferret

IN a previous paper, W. J. Hamilton dealt with the early development of the ferret from fertilization to the formation of the prochordal plate. A recent communication (*Trans. Roy. Soc. Edin.*, 59, (1), No. 5, 1937) carries on the investigation from that point up to the formation of the notochord and the mesoblast. The work is based on a full series of blastoderms from the appearance of the primitive streak up to the formation of seven somites, and in the interpretation the experimental work on Amphibia and Aves has been taken into consideration. The mesoblast differentiates from the ectoderm at the hinder end of the disk and no contributions are made to it by Henson's knot, the notochordal process or the prochordal plate. The anterior end of the differentiation of the primitive streak ceases when Henson's knot appears a short distance in front of it and thereafter it only grows by additions at its hinder end. The downward growth of Henson's knot fuses with the underlying endoderm.

New Species of Mysidacid Crustaceans

PROF. WALTER M. TATTERSALL describes some interesting new mysids ("Reports on the Collections obtained by the first Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep". Johnson Fund. Smithsonian Miscellaneous Collections, 91, No. 26 ; 1937. Pub. 3413). In addition to the new species, the rare *Lophogaster longirostris*, *L. spinosus* and *Petalophthalmus oculatus* are recorded. A key is given to the species of the genus *Paralophogaster* and a new species *P. atlanticus* added, which differs from *P. glaber*, the type of the genus, in the eyes, antennal scale, rostral plate and telson. All these Atlantic species are closely related, and it is a question whether *P. macrops* described by Colosi from the Red Sea may not be a young form of *P. glaber*. *Gastrosaccus johnsoni* n.sp. is peculiar in its male pleopods, which are very distinctive, especially those of the second and third pairs, and at once distinguish the species from all others of the genus, the females differing only in minor characters.

Asiatic Flower-Birds and American Bird-Flowers

IN the warmer regions of Africa, Asia and America, many flowers are pollinated by birds. In America the birds visiting the flowers are mostly humming birds which hover as they drink the nectar ; in Asia the birds climb over the branches and extract the nectar when in a hanging or sitting position. W. L. Van der Pijl has therefore spent some time examining the efforts of the sun birds (Nectariniidæ) and white-eyes (Zosteropidæ) to visit American bird-flowers introduced into Java (*Ann. du Jard. Botanique de Buitenzorg*, 48, Pt. 1 ; 1937). The original paper must be consulted for details ; but, as might be expected, though often visited by the birds, most of these flowers remain sterile ; in many cases the calyx or corolla tube has been punctured to enable access to be obtained to the nectar.

Insolation and Relief

THE indirect importance of relief in mountain regions in determining the distribution and intensity of sunshine on different slopes is demonstrated for selected alpine valleys in Switzerland and Austria in a monograph entitled "Insolation and Relief" by Miss A. Garnett (Publication No. 5. The Institute of British Geographers, 1937). From values assessed for sun altitude and direction, valley azimuth and degree of slope, maps and graphs are constructed for the two solstices, the equinoxes and days in early and late summer. The features which they portray are correlated closely with field studies giving details of land utilization, upper limits of crop production, and the distribution of permanent settlements. The results suggest that long duration rather than high intensity of insolation is the factor of most importance geographically, both in determining the upper limits and distribution of cereal cultivation and the position of permanent winter settlements. It is also shown that at some seasons of the year *ubac* (north-facing) slopes that are generally assumed to have low duration of sunshine, in actual fact may have a longer duration than the *adret* (south-facing) slopes, notably in the critical periods of early and late summer. This helps to explain what otherwise seems to be an unusual distribution of habitations and of cultivations in the valleys selected for study.

Crust Displacements in Japan

SERIES of re-levellings recently made in Japan show that, in many districts, chronic crustal deformations are now taking place. In order to study the connexions between such movements and the occurrence of earthquakes, revisions of the levelling have been made in various parts of the country, and especially in 1936 in the southern island of Kyûshû. A comparison between these measurements and those made, for the most part, about forty years ago, has been made by Prof. N. Miyabe, to whom we are indebted for much useful work of the same nature (*Proc. Tokyo Imp. Acad.*, **13**, 257–260; 1937). The island is almost bisected by an east-west line between Udo and Nobeoka. In the northern half, the general movement is a tilting of the crust towards the north, the northern end having subsided relatively by about 7 in. To the south of the median line, from Udo to Minemata, the crust has risen as a whole, but, to the south of the latter place, the displacements show marked fluctuations, so that the curve representing them consists of segments of lines. In other words, the movements recorded are those of crust-blocks rather than of the island mass as a whole.

Potential of the Iodine Electrode

THE normal potential of the mercury-mercurous iodide electrode, previously known only by calculation, has been determined by R. G. Bates and W. C. Vosburgh (*J. Amer. Chem. Soc.*, **59**, 1188; 1937). The cell consisted of a mercury-mercurous iodide electrode, with electrolytes of potassium iodide and hydrochloric acid, or potassium iodide, acetic acid and sodium acetate, combined with a hydrogen electrode. The E.M.F. values were extrapolated by an equation involving the activity coefficient of hydrochloric acid. In a second series of cells the electrolyte consisted of potassium iodide, sodium acetate and acetic acid, and the extrapolation now involved the molality of unionized acetic acid. The two sets of values were in good agreement, extrapolation to infinite dilution giving the value $E°_{25} = -0·0405$ volt. By combining this with the value of the electromotive force of the cell consisting of lead amalgam, lead iodide, mercurous iodide and mercury, a value for the normal potential of the iodine electrode could be calculated. This was found to be $E°_{25} = -0·5356$ volt, in better agreement with the value given by Lewis and Randall, namely, $-0·5357$ volt, than that in the International Critical Tables, $-0·5345$ volt.

The β-rays from Lithium and Boron Isotopes

THE radio-elements ^{8}Li and ^{12}B, obtained by bombarding lithium and boron with fast deuterons, give β-rays with energies up to 12 million volts. D. S. Bayley and H. R. Crane (*Phys. Rev.*, **52**, 604) have investigated the upper energy limits of these spectra, and J. J. Turin and H. R. Crane (*ibid.*, 610) have used the elements as a source in a study of the energy loss of energetic electrons in lead and carbon plates. The β-rays were investigated by a cloud-chamber in a magnetic field, the target being bombarded with deuterons immediately before the expansion. Both β-ray spectra have by inspection upper limits at $12·0 \pm 0·6$ Mev. Since the masses of the atoms involved in the formation and disintegration of ^{8}Li, ^{12}B, are known, the spectra may be used for testing the validity of the theoretical formulæ of Fermi and of Konopinski and Uhlenbeck for the shape of the upper limit. The question is complicated by the fact that protons are produced with unknown energy in the formation of ^{8}Li and ^{12}B; but accepting indirect evidence for the energy of these particles from the excitation functions, it is found that the Konopinski-Uhlenbeck theory gives considerably too high extrapolated values for the maximum energy of β-emission. The energy loss of β-particles up to 11 Mev. going through carbon is in good agreement with the Bethe-Heitler theory, the loss in lead is more than 50 per cent greater than predicted, but much of this difference is to be accounted for by the scattering of the electrons in the lead, which causes the path in the metal to be considerably greater than that directly measured.

Physical State of Jupiter's Atmosphere

ABOUT three years ago, Dr. H. Jeffreys suggested that Jupiter was composed of a rocky core surrounded by a thick layer of ice, the latter being covered by an atmosphere with a depth of more than 6,000 kilometres. Mr. B. M. Peek (*Mon. Not. Roy. Astro. Soc.*, **97**, 8, June 1937) suggests that such an atmosphere cannot exist, his method being an examination of an adiabatic model, an isothermal model, and finally an intermediate model which is a compromise between the first two. For the purpose of numerical evaluation, in the adiabatic and isothermal models the atmosphere is considered to be methane, and in the case of the intermediate type different proportions of hydrogen and methane are taken, and pressure-depths curves are drawn which show the depth at which the solid state is reached. If the atmosphere were composed of pure methane, this depth would be only about 35 km., and if pure hydrogen it would be 270 km. Whatever model be adopted, the depth of the atmosphere is probably limited to about 1 per cent of the radius of the planet. Mr. Peek directs the attention of meteorologists studying Jupiter to the fact that great densities are rapidly attained in the atmosphere, which would almost certainly lose its familiar characteristics below a depth of 25 km.

Science News a Century Ago

Kew Gardens

THE botanic gardens at Kew were founded by Princess Augusta, mother of George III, who began the formation of an exotic garden in 1759 with William Aiton (1731–93) as gardener. The small temples in the grounds were designed by Sir William Chambers in 1760–62. From 1772 until 1819 the gardens were under the care of Sir Joseph Banks. After his death they were neglected, and on October 31, 1837, *The Times* published a communication "From a Correspondent", directing attention to the state of the Gardens. "The great fault in the management at Kew-gardens", said the writer, "appears to be the adherence to a system of niggardly expense and exclusiveness. There does not appear to have been the slightest progress in improvement for many years; the old conservatories and hot-houses seem crammed with plants, in a state of decay or stagnation; everything looks dingy and dirty. . . . There are not sufficient persons in the grounds to attend properly to the cultivation; it is understood that nine or ten men is the whole strength of the establishment, to look after the botanical-garden and also the 'Arboretum', which two divisions it is believed cover nearly six acres of ground. . . . It may as well be mentioned, that a little repair would not hurt one or two of the temples in the pleasure-grounds; and it would also be quite as well if the piece of water, once called the lake, but now an unseemly pond, were emptied of its mud and filth, or quite filled up."

The gardens were rescued from this state of neglect by the work of Sir William Jackson Hooker (1785–1865), who was appointed director in 1841.

The Civil Engineer and Architect's Journal

IN October 1837 appeared the first number of the above monthly journal. In the prospectus printed in the first number, it was stated that the journal would contain descriptions and particulars of important buildings, manufactories, warehouses, railways, docks, bridges, piers, harbours, canals, rivers, water-works, gas-works, drainage, mining, steam navigation and machinery, together with notices of the transactions of British and foreign societies, new inventions, patents, books, parliamentary proceedings and "such other useful information connected with the Profession as may make it a work of general reference". The journal was published at 6*d*. a copy.

The Zoological Society

AT a meeting of the Zoological Society held on November 2, 1837, attention was directed to the falling off of the receipts for admission to the gardens, and suggestions were put forward for providing further attractions. Mr. Vigors, M.P., suggested that a suspension bridge should be built to communicate with the grounds of the Society on the opposite side of the Regent's Canal and that bands should be introduced occasionally. In replying to the discussion the chairman, the Rev. John Barlow, F.R.S., said the Council had appointed a committee to report on the deficiency in the garden receipts and that a spirited attempt was being made to introduce two living hippopotami into the collections.

Gresham College

UNDER the above heading, *The Times* of November 3, 1837, said: "Yesterday being the first day of term these lectures commenced in the lecture-room over the east side of the Royal Exchange, when Dr. Southey gave the first of his course on physic. The number of the auditory was 35 persons, or about half the number to which the room could afford accommodation, and which being greater than on previous occasions is to be attributed to the greater additional interest felt by the inhabitants of the city on the subject of this endowment from the steps which have recently been taken to render it more public and useful. The subject chosen by the learned lecturer was the history of medicine."

Dr. Henry Herbert Southey (1783–1865) was the younger brother of Robert Southey, the poet. He was physician to both George IV and Queen Adelaide. He was appointed to the chair of physic in Gresham College in 1834.

Baron Alibert (1768–1837)

JEAN LOUIS ALIBERT, the founder of modern dermatology in France, was born on May 26, 1768, at Villefranche-de-Rouergue in the Aveyron department of France, the son of a magistrate. He studied medicine in Paris, where his principal teachers were Pinel and Bichat, and qualified in 1799 with a remarkable thesis on pernicious fevers, of which several editions were published. His rise in the profession was very rapid, as two years after qualification he was made assistant physician and in the following year full physician to the Hôpital Saint-Louis, which he made the Mecca of dermatologists throughout the world. In addition to several books on diseases of the skin, of which the most important was published in parts between 1806 and 1814, and in which coloured plates appeared for the first time in the history of dermatology, Alibert deserves recognition for his works on therapeutics, of which he was the first professor in the Paris faculty, and a monograph on hydrology. He also won the Montyon prize for a work entitled "Physiology of the Passions", which was translated into German and Spanish. He was the recipient of many honours both at home and abroad. He was physician to Louis XVIII and Charles X, who created him a baron. His death, due to cancer of the stomach, took place on November 4, 1837.

Schönbein and Faraday

IN a long letter to Faraday dated November 5, 1837, Schönbein said: "The french papers have been talking for some time about a discovery (said to have been made by a certain Mr. Sorel a Frenchman) which if it should turn out to be something more than a mere news-papers' invention, would be indeed a most wonderful thing. By dint of god knows what sort of substance, the news-papers call it voltaic-powder, Mr. Sorel is said to be able of changing Iron and any other readily oxidable metal such as to give them (with regard to their chemical bearings to oxigen) the properties of the precious ones. Such a discovery, of course, cannot be made in our days without being turned to practical advantage and so, indeed, the papers tell us, that Mr. Sorel is going to enter into partnership with the well-known Mr. Cockerill in order to make use of his discovery in the large establishments of the latter gentleman."

University Events

Cambridge.—R. L. M. Synge, of Trinity College, has been appointed to the Benn W. Levy studentship in biochemistry.

The following grants have been made from the Balfour Fund: £50 to Dr. D. G. MacInnes for research on Tertiary and Quaternary fossil Mammalia of the Rukwa Basin; and £25 to H. W. Lissmann for research at Naples on animal locomotion.

The degree of master of arts has been conferred upon Prof. T. Dalling, professor of animal pathology.

In accordance with its usual practice, Trinity College announces the offer of a research studentship open to graduates of other universities who propose to go to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be as much as £300 a year if the pecuniary circumstances of the successful candidate require so large a sum. Candidates must not have reached the age of twenty-six years before May 1, 1938. Trinity College also offers, as usual, Dominion and Colonial exhibitions to students of Dominion and Colonial universities who wish to go to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. These exhibitions are of the titular value of £40, but the College Council has power to award an additional payment. A candidate for a studentship or exhibition should apply through the principal authority of his university, and his application should reach the Senior Tutor (from whom further particulars may be obtained) by May 1, 1938.

Leeds.—The title of emeritus professor has been conferred upon Dr. G. W. Watson, formerly professor of medicine in the University.

London.—Mr. T. C. Stamp has been appointed to the University readership in bacteriology tenable at the British Postgraduate Medical School. Since 1933 he has been lecturer in bacteriology at the London School of Hygiene and Tropical Medicine.

Dr. A. R. Todd has been appointed as from October 1 to the University readership in biochemistry tenable at the Lister Institute of Preventive Medicine. Since 1936 he has been an assistant in the Biochemistry Department of that Institute.

The title of reader in zoology in the University has been conferred on Mr. H. R. Hewer, in respect of the post held by him at the Imperial College of Science and Technology.

The title of emeritus professor of plant physiology in the University has been conferred on Prof. V. H. Blackman, on his retirement from the University professorship in plant physiology at the Imperial College—Royal College of Science.

An offer by Mr. A. Chester Beatty to provide a scholarship in radiology of £400 a year for two years has been accepted with the cordial thanks of the University. This scholarship will enable a student of radiology, after obtaining the academic diploma in medical radiology, to spend a year in one of the great radiological clinics of the United States.

Reading.—The honorary degree of D.Sc. will be conferred on the following at a Congregation to be held on November 29, on the occasion of the installation of Sir Samuel Hoare as chancellor of the University: Prof. James Chadwick, Sir Warren Fisher, the Right Hon. the Earl of Iveagh, Sir Thomas H. Middleton and Sir Edward B. Poulton.

Societies and Academies

Paris

September 6 (*C.R.*, 205, 453–472).

Arnaud Denjoy: The singularities of the analytical function defined by a Weierstrass element.

Marcel Brelot: The best or smallest harmonic majorants of sub-harmonic functions.

Mme. Nathalie Demassieux and Basile Federoff: The dehydration of the double sulphate of copper and potassium. The changes produced by loss of water on gradual heating have been followed by means of X-ray diffraction diagrams (Debye and Scherrer method). The X-ray photographs for $CuSO_4$, $5H_2O$ and $K_2Cu(SO_4)_2 . 6H_2O$ for ten stages of heating are reproduced.

Tryphon Karantassis and Constantin Vassiliadès: The preparation of the stannoalkyl diiodides and their action on aromatic amines.

André Meyer and Henri Drutel: The condensation of the 2, 6-dimethyl and 2, 8-dimethyl 4, hydroxyquinolines and their derivatives with aromatic aldehydes.

Henry Hubert: Storm squalls in western Africa.

Roger Gautheret: Some properties of the apical cells of *Lupinus albus*.

Gaston Ramon: The utilization of anatoxins in the treatment of toxi-infections in the course of development. Sero-anatoxitherapy.

Brussels

Royal Academy (*Bull. Classe Sci.*, 23, No. 6, 1937).

L. Godeaux: Remarks on algebraic varieties of bigenus one.

G. A. Boulenger: Some advice to naturalists on how to express themselves in their publications, and on the subject of certain errors to be avoided.

M. Kourensky: The integration of linear partial differential equations of the first order in two or more unknown functions.

P. Burniat: Hypersurfaces and canonical varieties.

Miss D. Crespin: The spectral classification of stars of type *B* and the distribution of absorbent elements in the interior of stellar atmospheres.

M. Nicolet: Note on the hydrogen molecule of stellar atmospheres.

P. Ledoux: The equilibrium of molecular dissociation in the interior of a stellar atmosphere.

Miss F. Dehalu: New researches on the $^2\Sigma - {}^2\Sigma$ band system of the AlO molecule and astrophysical applications.

B. Rosen and Miss J. Mat: Isotopic effect in the resonance series of Te_2.

M. Nicolet: Identification of new lines of NH in the spectrum of the sun's reversing layer.

G. A. Homès, M. Brunin and P. Duwez: The state of dislocation of cold-worked metallic crystals.

J. Claeys and H. Sack: Some remarks on the absorption of ultra-sound in tubes.

L. Marton: The electronic micrography of biological objects.

Bull. Classe Sci., **23**, No. 7, 1937.

L. GODEAUX : Cyclical involutions belonging to an algebraic variety of genera one.

TH. DE DONDER : The velocity of a coupled reaction.

TH. DE DONDER and J. PELSENEER : The velocity of propagation of light according to Descartes. Contrary to the opinion prevailing at the time of its publication, Descartes' theory did not imply the instantaneous propagation of light.

J. F. COX : Some remarks on a note by Nisoli and Gérard on a new determination of the vertex of the cluster in Taurus and of the star stream in Scorpio-Centaurus.

MRS. J. HENRY-CORNET and L. HENRY : Estimation of bilirubin in blood serum by the spectrographic method.

N. BOUTAKOFF : The flow northwards of Lake Tanganyika during the Pleistocene.

Washington, D.C.

National Academy of Sciences (*Proc.*, **23**, 351–421, July 15, 1937).

C. C. TAN : 'Compressed deficiency' and the location of the spindle attachment in the *X*-chromosome of *Drosphila pseudo-obscura*.

G. W. BEADLE and B. EPHRUSSI : Ovary transplants in *Drosophila melanogaster* : meiosis and crossing-over in superfemales. The ovaries of superfemales (individuals containing three *X*-chromosomes and two antesomes) have been successfully transplanted into normal females. Although such females are low in viability and always sterile, the transplanted ovaries gave fertile eggs. Mortality of eggs and larvæ was high, however, and this and other results suggest that this particular lack of chromosome balance interferes with crossing-over and hence with the mechanism of meiosis.

A. H. STURTEVANT : An effect of the *Y*-chromosome on the sex-ratio of inter-racial hybrids of *Drosophila pseudo-obscura*.

A. MARSHAK : Effect of X-rays on chromosomes in mitosis. For both plant and animal tissue, chromosomes are most sensitive to X-rays at the onset of prophase ; the frequency of induced abnormalities is independent of wave-length but varies directly as the total length of the chromonemata. The diameter of the 'sensitive volume' of all the chromonemata studied is of the same order of magnitude, and agrees with that of the average diameter of a polypeptide chain or a protamine molecule. Changes in sensitivity to X-rays induced by treatment with ammonia and carbon dioxide also suggest that the 'sensitive volume' consists of material of the type of the protamines or histones.

A. TYLER and N. H. HOROWITZ : The action of certain substituted phenols on marine eggs in relation to their dissociation. 2,4-Dinitrophenol and various substituted phenols increase the respiratory rate of sea-urchin eggs and at maximum stimulation prevent cleavage ; the effect is reversible. The effect on cleavage depends on the concentration of undissociated compound present. Once inside the cells, however, it is the dissociated form that is active.

G. N. SNELL and P. C. AEBERSOLD : The production of sterility in male mice by irradiation with neutrons. As with X-rays, the first result of irradiation with neutrons is reduction of litter size, followed by temporary sterility ; but neutrons, as measured by ionization in the bakelite-walled thimble chamber of a standard roentgen meter, are 5-6 times as effective as X-rays.

T. M. SONNEBORN : Sex, sex inheritance and sex determination in *Paramecium aurelia*. In a certain race of this organism, it was found that the individuals could be divided into two classes, sex I and sex II ; members of different classes unite for conjugation, while those of the same class do not. Provided neither endomixis (disintegration of meganucleus and its replacement by a fission body of the micronucleus) nor conjugation occurs, all products of fission are of the same sex as their progenitor. At conjugation or endomixis, sex differentiation occurs.

W. J. ROBBINS and MARY A. BARTLEY : Thiazole and the growth of excised tomato roots. While excised tomato roots do not grow in a nutrient solution of mineral salts and pure cane sugar, addition of yeast enables them to grow satisfactorily. For the yeast, one of its constituents, crystalline vitamin B_1, can be substituted. Since vitamin B_1 has been synthesized from pyrimidines and a thiazole derivative, these parent substances were tested, and it was found that the thiazole compound enabled growth to continue. Presumably the thiazole radical of vitamin B_1 is the active substance.

W. J. ROBBINS, MARY A. BARTLEY, A. G. HOGAN and L. R. RICHARDSON : Pyrimidine and thiazole intermediates as substitutes for vitamin B_1. Neither of these classes of compounds can cure experimental polyneuritis in pigeons, but 5 mgm. doses of each, if given not more than 24 hours apart, are effective. It is considered that vitamin B_1 is synthesized from these intermediates *in vivo*.

L. H. GERMER and K. H. STORKS. The structure of Langmuir-Blodgett films of stearic acid. Electron diffraction patterns were obtained from such multiple films deposited on a block of chromium-plated nickel. These patterns indicate that the carbon atoms in these crystals are arranged in zigzag planar chains, the axes of which are nearly, if not accurately, parallel to each other, this direction being inclined downward towards the water surface from the plane of the supporting block. Crystallographic constants have been deduced and the cross-section of the stearic acid reciprocal lattice constructed. The results have been confirmed by the examination by transmission of similar built-up films deposited on a very thin transparent backing foil.

C. STOCK : A peccary skull from the Barstow Miocene, California.

F. D. MILLER : Note on galactic structure : the Milky Way from Aquila to Cygnus.

O. ZARISKI : Some results in the arithmetic theory of algebraic functions of several variables.

N. A. HALL : Binary quadratic discriminants with a single class of reduced forms in each genus.

D. LEWIS and M. J. LARSEN : The cancellation, reinforcement and measurement of subjective tones. Experimental results indicate that an audible subjective tone can be increased or decreased in loudness by the introduction of a harmonic of pitch the same as that of the subjective tone. Reinforcement seems to be due to constructive interference, and cancellation to destructive interference ; hence the magnitude of the subjective tone can be measured in terms of an equivalent amount of sound pressure. It is suggested that subjective tones have representation in terms of actual vibrations in the cochlea.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, November 1

INSTITUTION OF ELECTRICAL ENGINEERS (MERSEY AND NORTH WALES (LIVERPOOL) CENTRE), at 7.—Prof. J. Chadwick, F.R.S.: "The Elementary Particles of Matter" (Kelvin Lecture).

Tuesday, November 2

CHADWICK PUBLIC LECTURE (at Manson House, 26 Portland Place, W.1), at 5.30.—Dr. J. M. H. MacLeod: "Leprosy in Great Britain at the Present Time" (Malcolm Morris Memorial Lecture).*

INSTITUTION OF CIVIL ENGINEERS, at 6.—S. B. Donkin: Presidential Address.

Thursday, November 4

INSTITUTE OF FUEL (at the Junior Institution of Engineers, 39 Victoria Street, S.W.1), at 6.—Symposium on "Waste Heat Boilers".

Friday, November 5

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. F. W. Lanchester, F.R.S.: "The Gas Engine and After" (Thomas Hawksley Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, at 7.—Dr. G. S. Baker: "Development of Hull Form of Merchant Vessels" (Andrew Laing Lecture).

INSTITUTION OF GAS ENGINEERS, November 2–3.—Ninth Annual Research Meeting to be held at the Institution of Mechanical Engineers.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

TEACHER OF ELECTRICAL ENGINEERING in the Norwich Technical College—The Principal (November 3).

CHEMIST (male) at the Royal Ordnance Factory, Irvine—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (November 5).

SCIENTIFIC OFFICER (chemistry), SCIENTIFIC OFFICER (physics), ASSISTANT (grade I, male), and ASSISTANT (grade III, female) in the Research Department, Woolwich, London, S.E.18—The Chief Superintendent (November 5).

PRINCIPAL of the St. Helen's Education Committee—The Director of Education, Education Office, St. Helen's (November 6).

LECTURER IN ELECTRICAL ENGINEERING in the Forest of Dean Mining and Technical School—The Secretary, County Education Office, Shire Hall, Gloucester (November 8).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY in the King's College of Household and Social Science, Campden Hill Road, London, W.8—The Secretary (November 8).

LECTURER IN PHYSICS in the West Ham Municipal College, Romford Road, London, E.15—The Principal (November 10).

PROFESSOR OF MECHANICAL ENGINEERING in the Bengal Engineering College—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (November 12).

ASSISTANTS (grade III) in the Admiralty Chemical Pool—The Secretary of the Admiralty (C.E. Branch) (November 13).

PROFESSOR OF BOTANY in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 88A, Gower Street, London, W.C.1 (November 30).

ELECTRICAL ENGINEER in the Copper Development Association, Thames House, Millbank, London, S.W.1—The General Manager.

LIBRARIAN in the University of Liverpool—The Registrar.

Official Publications Received

Great Britain and Ireland

Sale of Food and Drugs. Extracts from the Annual Report of the Ministry of Health for 1936–37 and Abstract of Reports of Public Analysts for the Year 1936. Pp. 16. (London: H.M. Stationery Office.) 4*d.* net. [1410

Bacon Development Board (Research Department). Report No. 7: Selected Abstracts on Pig Production made during the Year ending June 30th, 1937. Pp. lxi. (London: Bacon Development Board.) 2*s.* 6*d.* [1510

British Museum and British Museum (Natural History). Annual Report of the General Progress of the Museums for the Year 1936; with a Return of the Number of Persons admitted to the Museums and a Statement of the Principal Objects added to the Collection. Pp. 24. (London: H.M. Stationery Office.) 4*d.* net. [1510

Universities Bureau of the British Empire. Report of the Executive Council together with the Accounts of the Bureau for the Year 1st August 1936 to 31st July 1937. Pp. 24. (London: Universities Bureau of the British Empire.) [1610

Other Countries

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 15. Pp. iii+193. (Paris: Les Presses universitaires de France.) [1210

Ministère de l'Education nationale: Université de Paris, Faculté des Sciences: Institut de Physique du Globe. L'Observatoire géophysique de Chambon-la-Forêt. Pp. 20. (Paris: Imprimerie Gauthier-Villars.) [1210

Indian Lac Research Institute. Bulletin No. 27: A Technical Process for Washing and Refining Stick Lac. By A. K. Thakur. Pp. 13+2 plates. (Namkum: Indian Lac Research Institute.) 3 annas. [1310

Bulletin of the American Museum of Natural History. Vol. 73, Art. 8: Skull Structure of the Multituberculata. By George Gaylord Simpson. Pp. 727–763. (New York: American Museum of Natural History.) [1310

Bulletin of the Bingham Oceanographic Collection. Vol. 6, Art. 3: Report on Hydrographic Observations at a Series of Anchor Stations across the Straits of Florida. By Albert Eide Parr. Pp. 62. (New Haven, Conn.: Yale University.) [1310

Royal Agricultural Society, Cairo. Technical Bulletin No. 31: Experiments in Egypt on the Interaction of Factors in Crop Growth. 7: The Influence of Manuring on the Development of the Cotton Crop. By Dr. Frank Crowther. Pp. 70. Technical Bulletin No. 32: Experiments in Egypt on the Interaction of Factors in Crop Growth. 8: Manuring of Cotton in Egypt. By Dr. Frank Crowther, Adolf Tomforde and Ahmed Mahmoud. Pp. 38. (Cairo: Royal Agricultural Society.) [1310

Bulletin of the National Research Council. No. 100: An Experimental Study of the Problem of Mitogenetic Radiation. By Alexander Hollænder and Walter D. Claus. Pp. 96+4 plates. (Washington, D.C.: National Research Council.) 1 dollar. [1410

U.S. Department of Agriculture. Circular No. 439: Parasitization of the Mediterranean Fruitfly in Hawaii, 1914–33. By H. F. Willard and A. C. Mason. Pp. 18. 5 cents. Picture Sheet No. 1: Tomato-Hookworms. Pp. 2. 5 cents. Picture Sheet No. 2: Mexican Bean Beetle. Pp. 2. 5 cents. Picture Sheet No. 3: Colorado Potato Beetle. Pp. 2. 5 cents. (Washington, D.C.: Government Printing Office.) [1410

Brooklyn Botanic Garden Record. Vol. 26, No. 3: Botanic Gardens of the World; Materials for a History. Pp. 149–354. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) 2 dollars. [1510

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Mémoire No. 79: Les fossiles du Jurassique de la Belgique avec description stratigraphique de chaque étage. Par Prof. Henry Joly. Pp. 246+3 plates. Deuxième partie: Lias inférieur. Mémoire No. 80: The Crocodile of Maransart (*Dollosuchus dixoni* Owen). By W. E. Swinton. Pp. 46+1 plate. Deuxième Série, Fasc. 8: Limides jurassiques de l'est du bassin de Paris. Par Dr. Colette Dechaseaux. Pp. 58+3 plates. Deuxième Série, Fasc. 10: The Anatomy of some Protobranch Mollusks. By Prof. Harold Heath. Pp. 26+10 plates. Deuxième Série, Fasc. 11: Revision des Onitides. Par André Janssens. Pp. 200+2 plates. Hors Série: Résultats scientifiques du voyage aux Indes orientales Néerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. Vol. 5: Vertébrés. Fascicule 4: Oiseaux, par Ch. Dupond; Säugetiere, von E. Schwarz. Pp. 72+3 plates. (Bruxelles: Musée Royal d'Histoire Naturelle de Belgique.) [1510

U.S. Department of Agriculture. Farmers' Bulletin No. 1780: How to Fight the Chinch Bug. By C. M. Packard and Curtis Benton. Pp. ii+22. (Washington, D.C.: Government Printing Office.) 5 cents. [1510

National Research Council of Canada. Moisture on Windows. By R. Ruedy. Pp. 8. (Ottawa: National Research Council.) [1510

State of Illinois: Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 21, Article 3: Studies of Nearctic Aquatic Insects. 1: Nearctic Alder Flies of the Genus *Sialis* (Megaloptera, Sialidæ), by H. H. Ross; 2: Descriptions of Plecoptera, by T. H. Frison. Pp. 53–99. (Urbana, Ill.: Illinois State Natural History Survey.) [1510

Meddelanden från Statens Skögsforsöksanstalt. Häfte 30, 1937. Pp. iv+716. (Experimentalfältet: Statens Skogsforsöksanstalt.) 12.00 kr. [1610

Astrographic Catalogue 1900·0. Sydney Section, Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 15: R.A. 12*h* to 18*h*, Dec. −54° to −56°, Plate centres Dec. −55°. Pp. 64. Vol. 16: R.A. 18*h* to 24*h*, Dec. −54° to −56°, Plate centres Dec. −55°. Pp. 32. (Sydney: Government Printer.) [1610

Catalogues, etc.

Apparatus for the Testing and Analysis of Oil, Tar and their Products. (Catalogue No. 15B, Section X.) Pp. iv+108. (London: Griffin and Tatlock, Ltd.)

Mandecal (Compound Calcium Mandelate B.D.H.) in the Treatment of Urinary Infections. Pp. 8. (London: British Drug Houses, Ltd.)

Instruments for the Measurement of High Vacua. (Mes. 1.) Pp. 8. (London: W. Edwards and Co.)

Numismatik: Bücher, Abhandlungen, Zeitschriften. (Antiquariatskatalog Nr. 714.) Pp. 136. (Leipzig: Gustav Fock, G.m.b.H.)

Recent Scientific and Technical Books

Volumes marked with an asterisk (*) have been received at "NATURE" Office

Mathematics : Mechanics : Physics

Anderson, William Ballantyne. Physics for Technical Students: Mechanics and Heat. Third edition. Med. 8vo. Pp. ix +378. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 15*s*.*

Berek, Max. Optische Messmethoden im polarisierten Auflicht, insonderheit zur Bestimmung der Erzmineralien, mit einer Theorie der Optik absorbierender Kristalle. Teil 1: Mikroskopische Methoden bei senkrechtem Lichteinfall. (Sonderdruck aus Fortschritte der Mineralogie, Kristallographie und Petrographie, Band 22, Teil 1.) Roy. 8vo. Pp. 104. (Jena: Gustav Fischer, 1937.) 10 gold marks.

Bergmann, Ludwig. Schwingende Kristalle: und ihre Anwendung in der Hochfrequenz- und Ultraschalltechnik. (Mathematisch-physikalische Bibliothek, Reihe 1, Band 93.) Cr. 8vo. Pp. 47. (Leipzig und Berlin: B. G. Teubner, 1937.) 1.20 gold marks.*

Bitter, Francis. Introduction to Ferromagnetism. (International Series in Physics.) Med. 8vo. Pp. xi +314. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 24*s*.*

Boer, J. H. de. Elektronenemission und Adsorptionserscheinungen. Nach dem englischen Ausgaben übersetzung von K. Siebertz. Roy. 8vo. Pp. 322. (Leipzig: Johann Ambrosius Barth, 1937.) 21 gold marks.

Brink, Raymond W. A First Year of College Mathematics. 8vo. (New York and London: D. Appleton-Century Co., Inc., 1937.) 12*s*. 6*d*. net.

Clark, C. H. Douglas. The Fine Structure of Matter: the Bearing of Recent Work on Crystal Structure, Polarization and Line Spectra. Being Vol. 2 of A Comprehensive Treatise of Atomic and Molecular Structure. Part 1: X-Rays and the Structure of Matter. Demy 8vo. Pp. xxxvi +216 +xxxvii–lxii. (London: Chapman and Hall, Ltd., 1937.) 15*s*. net.*

Clements, Guy Roger, and **Wilson, Levi Thomas.** Manual of Mathematics and Mechanics. Med. 8vo. Pp. viii +266. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 15*s*.

Daugherty, R. L. Hydraulics: a Text on Practical Fluid Mechanics. Fourth edition. Med. 8vo. Pp. xiii + 460. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 21*s*.*

Davies, George R., and **Yoder, Dale.** Business Statistics. Med. 8vo. Pp. vii +548. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 17*s*. 6*d*. net.*

Department of Scientific and Industrial Research: Illumination Research. Technical Paper No. 20: The Use of Coloured Light for Motor Car Headlights. Roy. 8vo. Pp. iv +32. (London: H.M. Stationery Office, 1937.) 9*d*.*

Epstein, Paul S. Textbook on Thermodynamics. Med. 8vo. Pp. xii +406. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 17*s*. 6*d*. net.*

Faraday Society. The Properties and Functions of Membranes, Natural and Artificial: a General Discussion held by the Faraday Society, April 1937. Roy. 8vo. Pp. 911–1152. (London and Edinburgh: Gurney and Jackson, 1937.) 12*s*. 6*d*. net.*

Fermi, Enrico. Thermodynamics. (Prentice-Hall Physics Series.) Med. 8vo. Pp. x +160. (New York: Prentice-Hall, Inc., 1937.) 3 dollars.*

Green, S. L. Hydro- and Aero-Dynamics: a Theoretical Textbook for Advanced Students of Aeronautics, Hydraulics, Physics and Mathematics. Demy 8vo. Pp. viii +166. (London: Sir Isaac Pitman and Sons, Ltd., 1937.) 12*s*. 6*d*. net.*

Herzberg, Gerhard. Atomic Spectra and Atomic Structure. Translated with the co-operation of the Author by J. W. T. Spinks. Med. 8vo. Pp. xv +257. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1937.) 18*s*. 6*d*. net.*

Hogben, Lancelot. Mathematics for the Million: a Popular Self Educator. Revised second edition. Med. 8vo. Pp. 658. (London: George Allen and Unwin, Ltd., 1937.) 12*s*. 6*d*. net.*

Ilin, M. Turning Night Into Day: the Story of Lighting. Cr. 8vo. Pp. 141. (London: George Routledge and Sons, Ltd., 1937.) 3*s*. 6*d*. net.

James, C. G. Crystals and the Crystal Structure of Metallic Compounds. Demy 8vo. Pp. 84. (London: Draughtsman Publishing Co., Ltd., 1937.) 3*s*. net.*

Jeans, Sir James. Science and Music. Cr. 8vo. Pp. x +258 +10 plates. (Cambridge: At the University Press, 1937.) 8*s*. 6*d*. net.*

Jenkins, Francis A., and **White, Harvey E.** Fundamentals of Physical Optics. Med. 8vo. Pp. xiv +453. (New York and London: McGraw-Hill Book Co., Inc., 1937.) 30*s*.*

Kallmann, H. Einführung in die Kernphysik. Roy. 8vo. Pp. vi +216. (Leipzig und Wien: Franz Deuticke, 1938.) 12 gold marks.*

MacRobert, T. M., and **Arthur, William.** Trigonometry. Part 2: Higher Trigonometry. Cr. 8vo. Pp. ix +203–341 +xi–xiii. (London: Methuen and Co., Ltd., 1937.) 4*s*. 6*d*.*

McVittie, G. C. Cosmological Theory. (Methuen's Monographs on Physical Subjects.) Fcap. 8vo. Pp. viii +103. (London: Methuen and Co., Ltd., 1937.) 2*s*. 6*d*. net.*

Middleton, L. R. A Textbook of Light. Second edition. Ex. Cr. 8vo. Pp. viii +288. (London: G. Bell and Sons, Ltd., 1937.) 6*s*.*

Mitra, S., and **Dutt, G. K.** A Text Book of the Differential Calculus. Cr. 8vo. Pp. xiv +302. (Cambridge: W. Heffer and Sons, Ltd., 1937.) 10*s*. net.*

O'Hara, C. W., and **Ward, D. R.** An Introduction to Projective Geometry. Demy 8vo. Pp. ix +298. (Oxford: Clarendon Press; London: Oxford University Press, 1937.) 12*s*. 6*d*. net.*

Osgood, William Fogg. Mechanics. Demy 8vo. Pp. xv +495. (New York: The Macmillan Co., 1937.) 21*s*. net.

Perucca, Eligio. Guida pratica per esperienze didattiche di fisica sperimentale. (Consiglio Nazionale delle Ricerche: Comitato Nazionale Fisico.) Sup. Roy. 8vo. Pp. xii +644. (Bologna: Nicola Zanichelli, 1937.) 90 lire.*

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