NATURE

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CONTENTS.

Science in Boys' Schools: The Administrative Aspect.[1]

THE issue by the Board of Education of the pamphlet before us is opportune, having regard to the development of secondary schools now being taken in hand. The report expresses the views of five of H.M. Inspectors and deals more particularly with observations in 39 boys' schools, mostly urban. As a rule, the schools contained more than 400 pupils and had Advanced Courses; high value is rightly attributed to the institution of these courses, which have brought about improvements in apparatus and equipment—including libraries—and, best of all, secured more highly qualified teachers. Throughout the report, references appear to the primary need for securing teachers of sufficiently wide knowledge, breadth of interest, and business capacity in management of the science side of a school in all its details, financial and technical as well as professional. The science master must be competent to design and revise syllabuses, to draft requisitions, to organise the economical use and repair of apparatus. It is suggested that university training departments should teach laboratory management, the need of which is even greater among science mistresses than with men.

The whole report is evidently the result of careful, fair-minded observation, and if the constructive suggestions are too restrained, there are fairly plain hints to any science master who looks for guidance. He is urged to aim at a really good standard of equipment, and school authorities are advised to provide for the gradual carrying out of well-planned schemes extending over a few years. There is no doubt that much can be done thus, particularly with subjects like electricity and optics where the apparatus is practically permanent.

The neglect of biological studies, and the narrowness of the syllabuses, are attributed to the over-specialisation which the universities require in candidates for degrees. At Cambridge and London, mathematics, physics and chemistry suffice for the preliminary years of the degree course. Boys who are not introduced to biology before leaving school seldom take up such study later—"in this matter we are in a vicious circle." It may be pointed out, however, that some alert headmasters of the larger Public Schools are developing biological classes, securing thereby an infusion of valuable thinking into the higher forms and an avenue to open scholarships which is not at all crowded at present. More than this is needed to cure the too urbanised outlook of our boys, but perhaps there is better hope for biology introduced from above to supply the sixth form "specialist" than from the

[1] Report of an Enquiry into the Conditions affecting the Teaching of Science in Secondary Schools for Boys in England. Pp. 28. (London: H.M. Stationery Office, 1925.) 3d. net.

nature study of the preparatory school. One wonders what would have happened if biology had changed places with engineering in the growth of Oundle School.

Another weakness in the present administration is the inadequacy of the provision of laboratory attendants. This is bad economy. An example is given of a very efficient school in which the laboratories are economically run, that is, with wise expenditure and without waste. The cost of apparatus and materials is 9*s.* per head and of wages 7*s.* 6*d.* per head, which is about one-third of the corresponding figures for the larger public schools. It would have been worth while to point out that to leave an unskilled youth to clean up is to expose a laboratory to risk of destruction by fire.

In view of the number of new schools now being planned, it is to be hoped that the Board of Education will issue some suggestions on the planning of general and advanced laboratories for boys and girls respectively. It is extremely difficult to alter a block of science buildings, and too many laboratories are built on a wrong assumption as to the number of pupils to be taught as a class. More and more pressure to reduce the staffing ratio will come, partly as the result of Burnham scales, and the Board of Education will be compelled to face the problem of the desirable size of classes in practical work.

In connexion with the Burnham Scales, it is unfortunate that the Board of Education refuses to recognise works experience as qualifying in any way for service increments. Two examples come to mind, both of university graduates, where recognition was granted by the local education authority and refused by the Board of Education. One of these had first-rate works experience and has designed and made, with the aid of his boys, most of the really good equipment for teaching mechanics and electricity in his school. The other had experience as assistant in the Cavendish Laboratory which has been of immense help to his teaching. Both men have now to accept lower salaries than if they had become teachers without such experience. Not all works experience is valuable, but it is sheer folly to put obstacles to teaching in secondary schools in the way of such men as those to whom we have referred. It is to be hoped that the new award will leave appointing authorities some discretionary power of recognition of such experience in instrument-making as calls for the study of scientific principles and the acquisition of manipulative skill.

In their concluding observations the inspectors return to the first essential—the quality of the teacher. Quite rightly, credit is given to the Science Masters' Association and the *School Science Review* for the useful work done in promoting discussion and interchange of opinion among teachers. A science teacher and inspector of long experience wrote recently to express his "deep indebtedness to NATURE for invaluable help during all my teaching career, especially during the years when I was almost cut off from science workers except for the holidays when the British Association brought the needed companionship of fellow-workers." Without insisting on any particular journal, it may be regarded as a bad sign if a science master is neglecting current scientific literature. The short courses arranged for vacations by the Board of Education are excellent and they are widely appreciated. Why are half the applications refused? If the Board is unwilling to spend the money, this is another bad economy. But considering the pressure in the opposite direction, it is perhaps fairer to thank the Board for all it is doing, especially the successful attention by which the courses are made of such direct value in the school-teaching of science. We are grateful for this Report, which we hope will be studied in detail by headmasters as well as science masters, and also by the administrative side of the Board.

The Unity of Social Science.

The Earth before History: Man's Origin and the Origin of Life. By Edmond Perrier. Pp. xxiv+34[illegible] 15*s.* net.

Prehistoric Man: a General Outline of Prehistory. By Jacques de Morgan. Pp. xxiii+304. 12*s.* 6*d.* net.

Social Organisation. By Dr. W. H. R. Rivers. Edited by W. J. Perry. Pp. xi+226. 10*s.* 6*d.* net.

Language: a Linguistic Introduction to History. By Prof. J. Vendryes. Translated by Dr. Paul Radin. Pp. xxx+378. 16*s.* net.

History and Literature of Christianity from Tertullian to Boethius. By Prof. Pierre de Labriolle. Translated from the French by Herbert Wilson. Pp. xxiii+555. 25*s.* net.

The Threshold of the Pacific: an Account of the Social Organisation, Magic and Religion of the People of San Cristoval in the Solomon Islands. By Dr. C. E. Fox. Pp. xvi+379+14 plates. 18*s.* net.

The History of Civilisation Series. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, Inc., 1924–1925.)

SOCIAL and cultural scholarship, or as we call it in its beginnings, humanism, was, in the development of modern European thought, born before natural science. But it has been badly out-distanced by its younger sister, and only of late can it be seen emerging out of disorganisation and chaos. Nor is the road quite clear yet. Is there any unity in the vast medley of "histories" and "philosophies" whether of language or of literature, of art or of political institutions,

economics or of morals, of law or of religion? In what relation do they stand to the old-fashioned history, pure and simple? Is *sociology* merely a new name for these studies taken in bulk, or does it stand for an attempt at unification in method, aim, and the adjustment of tasks?

To these questions, and to many other detailed ones, there is no answer yet on which all can be agreed, though philosophers and methodologists have been busy discussing them for some time, especially in Germany. There is, however, a marked tendency at present among the specialists as well as among those who survey matters from epistemological points of vantage to come into touch with each other, to recognise the unity of social science and to co-ordinate their work so as to avoid unnecessary duplication, to eliminate unhealthy specialism, and to foster the sole aim of humanism—the knowledge of man's nature, of his social organisation and of his culture.

The History of Civilisation Series, some volumes of which form the subject of this notice, promises to be perhaps the most important contribution so far undertaken towards the task of organisation and systematisation of the social studies. A glance at the prospectus makes us anticipate a library of masterpieces, for the best workers of France, Great Britain and some other countries are contributing from their own speciality and are attempting to bring it into line with the contributions from neighbouring fields and with the results of general sociology. Including all the volumes of the important French collection "L'Évolution de l'humanité," started a year or two ago and now in progress, the English Library, edited by Mr. C. K. Ogden, of Magdalene College, Cambridge, contains additions and improvements which will place it, no doubt, above its continental counterpart. The volumes already issued in English fully bear out our best hopes, and those additions which do not belong to the French series, the volumes by Dr. Rivers and Dr. Fox, establish its claim to superiority.

The whole plan of the English series is in itself a vindication of the unity of social science. Arranged so as to include all manifestations of human culture accessible to the eye of science, it follows roughly a combined historical and geographical plan. Starting from the most comprehensive picture, the empty earth in the midst of the empty universe awaiting the arrival of man, it passes then to the gradual development of organic life and the early history of mankind. These initial stages, described in the volumes of MM. Perrier and de Morgan, are accompanied by a series of introductory works which give a theoretical account of the various aspects of human culture: social organisation (by Dr. Rivers) and language (by Prof. Vendryes), the two tools of human action and of human thought; the geographical and the racial factors (in two volumes by MM. Febvre and Pittard); an epitome of man's political evolution (in the book of MM. Morel and Davy, "From Tribe to Empire"); a volume on man's primeval domesticity ("Woman's Place in Simple Societies," by Prof. J. L. Myres), and "Cycles in History" by the same writer.

The story then begins at the traditional cradle of culture, the ancient East, on the holy banks of the Nile, the Euphrates and Tigris, and on the shores of the Mediterranean, where the origins and history of the early Empires and their civilisations are described. Remaining within this geographical area, we follow the lead of time, and after having been shown the growth of the Ægean civilisation and the formation of the Greek people, we study the history of Greece in all its wonderful cultural achievements; next, in obedience to historical destinies, hegemony has to be surrendered to Rome, with the laws, politics and economic organisation of which we are then concerned, from the humble republican beginnings to the final expansion of the Empire. This brings us far beyond the geographical boundaries of the Mediterranean basin to the vast areas occupied by the Teutonic peoples to the north, the Persian, Indian and Chinese civilisation to the east, and the Mongol cultures of Central Asia. All these cultures will be studied in a series of monographs in a special section which closes the big division devoted to pre-history and antiquity. The second division will contain volumes on Christian religion, on the break-up of the Roman Empire, on the religious imperialisms of Christianity and Islam, on the political, social, economic and intellectual evolution in the Middle Ages and modern times. The English library contains besides all this several special sections, one on the histories of various subjects, such as medicine, money, costume, witchcraft and what-not; a section on Oriental culture, on historical ethnology, and a few more special sections not yet exhaustively announced, dealing with modern history.

The field of social science is thus fully and comprehensively covered in the English library. But this summary following merely geographical and chronological lines does not do full justice to the merits of the plan and of the achievements of the series, so far as they have been laid before us. It is the nature of the subjects treated in each group which constitutes its importance and makes it absolutely unique, as the first fully scientific history of civilisation in the English language. For there is no doubt that a deep modification in our conception of history has taken place during the last generation or so.

Take, for example, the history of Greece or Rome.

For most of us it has been, and still remains, the kernel of historical reality and the standard of our cultural values. Ancient Greece especially embodies for us the retrospective ideal of heroism, beauty and wisdom shining in the glory of a unique setting, of a chosen people and of an irrevocable past. We have our Golden Age in this myth of Greek culture, of Roman statesmanship, and this myth has been one of the main civilising forces from the Renaissance up to the present day. However science might deal with this mythology, scholars, dreamers and metaphysicians will still read into certain epochs of history an inspiring epic, a thrilling drama, a revelation of purpose and wisdom in destiny, a moral inspiration which allows man to bear the gloom and oppression of his own time. The reality of Homeric fights, of the Biblical stories and the myth of classical antiquity, will remain untouched for ever by the most destructive of "higher criticisms."

This is well, for we want our myth to remain intact, while at the same time the spirit of science forces history into accomplishing a different task from that of glorifying and idealising the past or of making it into a dramatic play of national destinies. The new history cannot carry out its work without the help of social science, psychology and a comparative study of culture. Scientific history, after it has thrown overboard drama, sentiment and myth, after it has introduced the most rigorous methods of scrutinising and reconstructing sources, still stands helpless before its main task: and that is to build up the process of human development in terms of personality and character as they work upon masses of people and as they solve questions of organisation and politics, of taxation and other economic arrangements, of warfare and education, of domestic, moral and religious institutions. For the knowledge of personality and character the historian might repair to the psychologist; in the study of organisation and politics the sociologist might help him; the scrutiny of values, whether material or moral, has to be carried on in collaboration with economics, the science of material culture, ethics and other normative disciplines.

Yet in all this the historian will find that he has quite as much to give as to take, for each of his auxiliary sciences has suffered by conducting its work single-handed and upon a somewhat artificially specialised material. The student of psychology has worked on an isolated, individual mind, suspended *in vacuo*, and he has wasted much of his time therefore in studying an unreal figment. Endless "sociologies" have been written upon a subject constructed *ad hoc*, whether it be the "group mind" or the "consciousness of kind," "imitation" or "race war" conceived as unique sociological principles, the "purely formal" in human organisation or the "exclusively organic." Economists have created another figment for science in the mathematically economic man who follows the purely economic motive. The moralist made his "absolute good," his "categorical imperative" or his "moral sense," and proceeded forthwith to study and to worship the idol fashioned by his own hands. Each specialist foredoomed his results by working on a figment. For human nature cannot be cut up into bits, nor man's mental endowment separated from his social habits or his material culture, or his moral and economic values. The human mind, with its plastic instincts shaped into cultural habits, its reason bound up with language and its emotional life determined by social bonds, values and ideals, is an integral subject of study. Specialisation there must be, and it probably will have to run on the traditional lines of psychology, sociology, economics, ethics and so on. But this specialisation must be the result of a central theory of human culture, this term of course embracing the human mind, the factors of organisation and material civilisation.

In this the historian, coming with his concrete, full-blooded reality of an individual civilisation at a definite epoch evolved by a definite race, forces the specialists to face the real problem. For in the concrete reality of life, regarded comprehensively and examined scientifically, we see how all the aspects intermingle and influence one another,—each sufficiently independent to require a specialised study, each at the same time so deeply influenced by the others that it must be studied against the background of the whole culture.

We can see this method well exemplified in the scheme of the Greek section in this library. The ethnographic foundation of Greek culture is given in the first volume on the formation of the Greek people. Economics, religion, art, science, politics are then studied in separate contributions, each written in a sociological spirit, each giving an analysis of one aspect of Greek culture, yet all connected into one comprehensive picture. The analysis of any other part of the scheme shows the same plan, and the names of the writers vouch for the fact that every contribution will be written in the modern scientific, that is, sociological spirit.

It is in this that the English series shows its superiority over the French library. In glancing over the prospectus of this latter, one or two capital omissions at once strike us forcibly. A series conceived in the sociological spirit should place perhaps two subjects in the forefront of its attention: economics and the study of domestic life. The importance of the former has been underestimated for ages by the historian, though it has certainly been over-emphasised in the modern theories of historical materialism. Nevertheless, childish as it is to regard wealth as the unique *vera causa* of all cultural process, its study cannot be omitted from any

scientific account of any type of civilisation. Even modern anthropology has begun to discover in theory and in field-work that the production and acquisition of material goods play a far greater part in primitive life than was ever suspected by the earlier authorities. In historical times, economics play an important part in the shaping of political history, of social organisation and of the other cultural pursuits, but certainly not as a unique and sufficient cause of everything, but as an element with which man cannot dispense, and which in consequence the student must not ignore.

The other factor, domesticity and family life, is, so to speak, the crucial test of really scientific anthropology and history. The most ubiquitous elements in man's life—the school of his infancy, the background of his youth and the aim of his age—the family and the household, are certainly the cell of human society, and their constitution influences deeply the other forms of social grouping in any culture. Modern psychology teaches us also that the early influences of the family leave a deep impression on the individual's mind and in consequence upon the whole cultural activity of a community. There is no doubt, however, that the scientific treatment of domesticity in its influence upon culture is extremely difficult. Just because it is so deep and powerful an influence, it is to some extent intangible and invisible; so that the modern historian finds in his sources only scanty and indirect information about the domestic life of the average individual, although archæology, folk-lore and even comparative anthropology can assist him in this to a great extent.

It is therefore a remarkable omission that in the French series the two subjects of economics and domestic life should have been almost completely neglected. This gap will be filled by Mr. Ogden in the English library, and he has summoned to this task the help of competent writers. The volume by Prof. J. L. Myres on "Woman's Place in Simple Societies," which is announced; the works on "Life and Labour in Greece and Rome," by M. Glotz and M. Paul Louis; the contribution on the regime of the castes in Ancient India, by Mr. G. S. Ghurye; the book on popular life in the last Roman Empire by Prof. N. Baynes; the volumes on "Life and Labour in the Middle Ages and in Modern Europe," by M. Boissonade and Prof. Renard, and on "Women in Medieval Times," by Dr. Eileen Power; the "Philosophy of Capitalism" and the "History of Money," both by Dr. T. E. Gregory—all these, confined to the English series—promise by their subjects to be among the most interesting volumes, and by their authors, among those of the greatest value in the library.

The comparison between the French and English series and the advantage derived from the combination of the best forces in two countries suggest the one serious criticism that could be made with regard to the present enterprise—the almost complete lack of German and American contributions. German scholarship in works referring to classical antiquity, in comparative linguistics, in many domains of psychology, in historical economics, jurisprudence and in the theory of the state is unrivalled. No one will suspect Mr. Ogden, the War-time editor of the *Cambridge Magazine*, of narrow-minded chauvinism or of any of the futile though unfortunately widespread prejudice against the science of a great nation. It is therefore to be hoped that in the pending additions to the series announced in the prospectus there will be included the works of some of the leading humanists of Germany.

It is also to be hoped that some of the best works of the United States to be published within the next few years will find their way into this series and make it even more representative and international. For in this big collective work on civilisation the unity of human culture and of human science should be manifested by the co-operation of different nations as well as in the intrinsic unity of the subject with which the authors are dealing. B. MALINOWSKI.

Real Builders of America.

A Popular History of American Invention. Edited by Waldemar Kaempffert. Vol. 1: Transportation, Communication, and Power. Pp. xvi+577. Vol. 2: Material Resources and Labor-Saving Machines. Pp. xiv+457. (New York and London: Charles Scribner's Sons, 1924.) 63*s.* net.

TO the extraordinary development of the United States during the last century, history presents no parallel. From a position of comparative insignificance she has risen to be the greatest manufacturing nation the world has ever seen. The growth of her industries has indeed been remarkable, and the real builders of her fortunes have not been her statesmen and soldiers, but her mechanics and inventors. While, however, the story of her national progress is fairly familiar, a knowledge of her pioneers and their work is not general, and it was therefore a happy thought to bring together this series of essays giving a review of the great things achieved.

It was to an American audience that Lord Playfair once remarked, "Science has no country though its investigators have birthplaces." In some degree the same may be said of invention, and frequently the plan of writing the history of either science or invention from the national point of view is unsatisfactory. Still, there are advantages if the work is done impartially, and fortunately the editor and writers of this popular

history of American invention have not been too eager to emphasise the work of their countrymen at the expense of others, and the sketches, though by many writers, are throughout eminently readable, entertaining, and informing. The work is well balanced; good accounts are given of scientific discoveries and mechanical inventions made in Europe before being taken up in the United States, and a large proportion of the illustrations are from the Science Museum, South Kensington, the Deutsches Museum of Munich, and other institutions. We thus read the old stories of Watt and Stephenson, Volta and Faraday, Gutenburg, and Daguerre and Daimler, in a new setting.

There are in all 27 chapters by 18 different writers, and the work is divided into five main parts devoted to transportation, communication, power, material resources, and labour-saving machines. The opening chapter deals with railways, and in the year which is seeing the celebration of the centenary of the Stockton and Darlington Railway this is of especial interest. American locomotives have long ago surpassed European engines in size and power, though not in speed and efficiency, and we are told that the largest goods engine, the Virginian, weighs 450 tons, and has no less than 10,725 square feet of heating surface in her boiler. The *Rocket* had 137 square feet. Several of the chapters give striking statistics; and in the first chapter it is stated that the United States now has 69,000 locomotives, 57,000 passenger cars, and 2,500,000 freight cars. The railways employ about 2,000,000 men.

After the story of the railways come those of the steam-boat, electric traction, motor cars and aeroplanes. The next group of chapters is devoted to printing, typewriting—in 1919 the world produced 875,000 typewriters, of which 775,000 were American—telegraphs, telephones, wireless, photography, "Pictures that Live and Move," and phonographs. Though the moving picture business owes its main development to American enterprise, a fair account is given of the work of Faraday, Plateau, Horner, Marey, and others, but the birthplace of the "movies" was Philadelphia, where at the Academy of Music in February 1870 Henry Heyl threw on the screen a series of pictures showing the movements of a couple waltzing. The reader is taken behind the scenes of a studio, and it will perhaps come as news to many to read that some of the accidents seen on the films are real ones, and that Hubert Kittles, a well-known motorist, "was in bed for weeks with broken bones after a realistic motor cycle race, in which the story called for a real tumble."

The second volume of the history treats of the great metallurgical, oil, timber, machine tool, and textile industries. We see how the inventions of Bessemer and Siemens led to the rise of Pittsburg, how petroleum wells are sunk, how giant forest trees are felled and transported, how the agriculture tractor came into being, and how boots are made by machinery, enabling the States to turn out 300,000,000 pairs of shoes a year. Machine tools had their birth in the shops of Wilkinson, Bramah, and Maudslay, but to-day they are designed by the staffs of professional inventors maintained by the great companies. They are characteristically American in the sense that they have been brought into being to solve the problem of producing vast quantities of metal articles cheaply in the face of high labour costs.

In the space of 1000 pages it was, of course, impossible for the writers to deal with all the pioneers. We thus miss any mention of James Rumsey and his steamboat, of Ericsson and his gun turret, of the work of the great iron master John Fritz, and of Robert M'Alpine the father of the wood pulp industry. In the chapter on the incandescent lamp, Swan should certainly have been referred to. But apart from these and other minor criticisms, it must be conceded that this popular history is one of the best books of its kind which have yet appeared.

Bird Life on the Norfolk Broads.

Broadland Birds. By E. L. Turner. Pp. xvi+172+5 plates. (London: *Country Life*, Ltd., 1924.) 15s. net.

THAT skilful watcher and photographer of birds Miss E. L. Turner, has published what she describes as "just a record of my own personal observations of the birds I have lived with for twenty years." She has had opportunities which many will envy, and has used them in a way which all must admire. She has spent the whole of many seasons in a house-boat on Hickling Broad, devoting herself entirely to the observation of bird-life in that interesting locality. By dint of much patient watching, she has acquired a great knowledge of the intimate lives of some of the most interesting and least accessible species. What she has learnt she faithfully records as a plain narrative, avoiding anthropomorphic interpretation on one hand and not attempting theoretical deduction on the other. The result will give much pleasure to lovers of birds, and at the same time is of considerable scientific interest.

Several noteworthy ornithological events are recorded in these pages, such as the first nesting of the bittern, in 1911, after it had been for long regarded as extinct as a British breeding bird, and the nesting of the ruff in 1907 after an interval of many years. The bittern, happily, is now re-established, but so far the ruff has not been found to nest regularly. Miss Turner also describes the first nesting of the cormorant

East Anglia for a century—on a high tree, as is commonly the case inland in Ireland and on the Continent.

Other chapters in the book deal with birds which range from comparatively uncommon species, such as the stone-curlew and the bearded tit, to familiar birds which may be found in marshlands throughout the country. About all of them we are told something of interest, but we are at the same time warned against hasty generalisation from the behaviour of a few individuals, because close observation reveals great differences in behaviour between one and another of the same species.

The writer has not always restricted her stay in Norfolk to the nesting season, but has also spent the autumn and winter in her house-boat. In late summer she has seen migrating swifts arriving from the north-east, appearing first at dawn as a faint cloud in the zenith which rapidly drops earthwards and resolves itself into a great host of birds. In autumn she has seen the vast concourse of millions of starlings which roost in the reed-beds and perform aerial evolutions on such a scale that the line may "stretch from Potter Heigham Church on the south to Hickling Hill on the north-west, a distance of five miles." In mid-winter, with the broads nearly ice-bound, she has seen such things as fifty-four swans, in strict chevron formation, passing across the face of the moon.

Miss Turner apparently began as a bird photographer, but she has become much more than that. Her book would indeed have been well worth reading, as a record of observations, even without the excellent photographs with which it is illustrated, although naturally they add much to its charm. Many of them are of value in depicting action instead of being portraits only.

Our Bookshelf.

La Géochimie. Par Prof. W. Vernadsky. (Nouvelle Collection scientifique.) Pp. vi + 404. (Paris: Félix Alcan, 1924.) 12 francs.

THIS book of four chapters is a reprint, with some amplification, of lectures given by Prof. Vernadsky at the Sorbonne during 1922–23. The first chapter, which opens with the questionable statement that geochemistry is a science new to the twentieth century, is devoted to general considerations, including the subdivision of the earth's outer layers or envelopes according to their physical, chemical and biological characteristics. Apart from the atmospheric layers, Vernadsky's various groupings of these envelopes may be indicated roughly as follows:

Superficial	Water and superficial crust	Biosphere.
Metamorphic	Sedimentary and granitic	Lithosphere.
Magmatic	Basaltic	Magmosphere.

Minerals stable in the superficial envelope are termed *vadose*, those in the metamorphic envelope *phreatic*, and those in the magmatic envelope *juvenile*. Cycles of change in the chemical composition of minerals are distinguished as *primary cycles* if their completion is effected in two or more envelopes, and *secondary cycles* if they are completed within the limits of a single envelope. The application of these notions is illustrated by a detailed account of the geochemical history of manganese, which furnishes an example of a primary cycle involving juvenile, phreatic and vadose changes. Chap. ii. deals with silica and the silicates, Chap. iii. with carbon and living matter, and Chap. iv. with the radioactive elements.

A notable feature of the book is the large place allotted by the author to biochemical agencies in mineral transformations. His account of the dynamic equilibrium between carbon dioxide and living matter, or what he calls the *vital cycle*, is of special interest from this point of view. His discussion of biochemical evidence, however, shows that he is an enthusiastic supporter rather than a critical examiner of the claims made for biochemical factors in geochemical changes. An example of this is provided by his reference to the process of laterisation, and his easy conviction that the process is clearly a biochemical one.

In a general way, Prof. Vernadsky's views are less likely to be challenged by chemists and physicists than by geologists; but it will be admitted by all that his book is full of interest on account of its largeness of outlook and its ample recognition of the many-sided character of geochemical problems. T. C.

Physics in Industry: Lectures delivered before the Institute of Physics. Vol. 2. By Dr. J. W. Mellor, Dr. A. E. Oxley, Prof. C. H. Desch. Pp. 48+6 plates. (London: Oxford University Press, 1924.) 3s. net.

THE appearance of a second volume of these valuable lectures on physics in industry evokes the thought—and the fear—that before long we may have a special society and a special journal devoted to this subject. But for the fact that engineering has hitherto been regarded as the one and only field of applied physics that matters, these would probably have seen the light many years ago. Industrial chemistry has long been in the public eye; industrial physics, apart from engineering, has yet to come into its own.

In his absorbing lecture on the applications of physics to the ceramic industries, Dr. Mellor was compelled by the tyranny of time to confine his remarks to applications that are not common to other industries, such as the drying of clay and clay wares, thermal and contraction strains in ceramic goods, and the electrical and thermal expansion of glazes. He deals lucidly and suggestively with these topics, and his general remarks on applied physics and physicists, if not entirely novel, are very sound. Dr. Oxley, as physicist to the British Cotton Research Association, has found, contrary to expectation, a vast field for research in the textile industries, and particularly in bringing scientific method into the testing-room. He points out that the distinguishing feature of physical research in this field is that, owing to great variability in the raw materials, series of observations sometimes involving many

thousands of readings have to be made, and conclusions drawn from them by statistical methods. As examples of the work to be done he discusses the testing of rigidity, elasticity under strains, effects of variable stresses, fatigue, regularity of the spun thread, and the appearance of the finished fabric. He concludes with the recommendation that abstracts on the progress of textile research should be given their place in the chief scientific journals. The third lecture, on the physicist in metallurgy, shows the enormous importance of physics in later-day metallurgical research and practice. The most numerous and varied applications of physics, states Prof. Desch, are connected with the heating, forging, hardening, and alloying of metals. Magnetism, he tells us, is becoming of increasing importance, and atomic structure, properties of crystals and X-ray analysis, are all of actual and potential value in metallurgical research. The lectures reach a high standard, and the introductory remarks by the Hon. Sir Charles Parsons concerning the rôle of higher mathematics in applied physical research should not be overlooked.

Arabische Alchemisten. Von Julius Ruska. 2: Ğa'far al-Ṣādiq, der sechste Imām. Mit einer Nachbildung der Handschrift Gotha A. 1292 (*Haleb* 338) *in Manuldruck.* (Heidelberger akten der Von-Portheim-Stiftung, Heft 10.) Pp. 128+62. (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1924.) 7·20 gold marks.

PROF. RUSKA'S erudition is equalled only by his energy. He has now followed up his monograph on Chālid ibn Jazīd (see NATURE, September 20, 1924, p. 427) with an interesting and important memoir on Ja'far al-Ṣādiq, the sixth Imām. Included in the memoir are the text and a translation (with full notes) of an alchemical treatise falsely attributed to Ja'far, the "Book of the Letter of Ja'far al-Ṣādiq on the Knowledge of the Art and of the Noble Stone." The text is a facsimile of MS. *A.* 1292 at Gotha, and is supplemented by additions and variations from a manuscript in the Library at Rampur.

The memoir is divided into six sections: (i.) Ja'far al-Ṣādiq in history and legend; (ii.) the writings attributed to Ja'far; (iii.) Ja'far as the teacher of Jābir ibn Ḥayyān; (iv.) Ja'far as the author of chemical works; (v. and vi.) translation and text of the alchemical treatise mentioned above. Prof. Ruska's main conclusions are that Ja'far had nothing whatever to do with alchemy, that all the alchemical works attributed to him are spurious, and that he could not have been the master of the great Jābir. He says that it is quite unthinkable (*völlig undenkbar*) that Ja'far al-Ṣādiq could, at Medina, have come into any contact with either practical or theoretical alchemy. If this conclusion is justified, it follows that Jābir could not have learnt alchemy from him, and Prof. Ruska is therefore forced to the extremely important conclusion that "all writings ascribed to Jābir, in which Ja'far al-Ṣādiq is represented as his master and teacher, are to be regarded as falsifications of a later date."

Prof. Ruska's conclusions are certain to have the happy result of provoking much further research, but we feel that it is as yet too early to give unqualified assent to his criterion for judging the authenticity of works ascribed to Jābir. His memoir is undoubtedly the most important contribution to our knowledge of early Islamic chemistry which has been made in the present century. E. J. H.

Statics: including Hydrostatics and the Elements of the Theory of Elasticity. By Dr. Horace Lamb. Second edition. Pp. xii+357. (Cambridge: At the University Press, 1924.) 12*s.* 6*d.* net.

PROF. LAMB'S books on the various branches of mechanics require no introduction to the modern teacher and student of applied mathematics. By their fluency of diction, their easy mathematical style and their lucid presentation of the subject, they have displaced most of the old-established works. The interest in the announcement of a new edition lies consequently rather in what modifications the author could possibly make to improve an already excellent work.

This second edition of "Statics" differs from the earlier edition merely in the portion dealing with elastic problems. There has been made, to the chapter on the extension of bars, a valuable addition on the treatment of redundancies. Castigliano's theorem of least energy is developed, with Southwell's simple and elegant proof. The chapter on the flexure and torsion of bars now covers the case of curved bars and the collapse of a ring under pressure, while the final chapter on stresses in cylindrical and spherical shells now includes the case of rotating cylindrical shafts.

These additions are consistent with the general tendency of all the author's work, to combine with clear and lucid mathematics a close association with the realities of the subject. This new edition merely emphasises the debt which all teachers owe to Prof. Lamb's inspiration.

Valenzkräfte und Röntgenspektren: zwei Aufsätze über das Elektronengebäude des Atoms. Von Prof. Dr. W. Kossel. Zweite, vermehrte Auflage. Pp. iv+8 (Berlin: Julius Springer, 1924.) 3·60 gold marks.

VALENCY and X-ray spectra may appear to have little in common, but valency is essentially connected with the number and distribution of the outer electrons of the atom, while X-ray spectra provide the most powerful weapon for the investigation of those which are more tightly bound; together, therefore, these two essays involve the whole question of electron distribution. The first section contains an interesting account of the various theories of valency, and considerable space is devoted to the bearing of the crystal lattice on the problem. This new edition has been slightly enlarged, notably by the inclusion of a brief account of the Lewis-Langmuir theory. Bohr's work on the periodic table is not discussed here, since the author has decided, rightly perhaps, that it could be treated more adequately in the second essay. Here Dr. Kossel has succeeded in giving, in small compass, an admirable account of X-ray spectra and their bearing on atomic structure. He emphasises the fact that an investigation of the energy levels indicated by these spectra leads to conclusions similar to those deduced from valency considerations. The first edition was deservedly popular, and no doubt this second edition will meet with equal success, giving, as it does, a clear yet concise account of these phenomena.

Letters to the Editor.

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

X-ray Crystal Analysis as an Auxiliary in Organic Chemical Research.

AT the suggestion of Prof. W. L. Bragg, I recently sent to Dr. G. Shearer, of the Davy Faraday Research Laboratory, a series of four keto-acids which had been synthesised by my wife. Dr. Shearer was not aware of the identity of the substances, which were, however, stated to belong to the series

$$CH_3(CH_2)_m . CO . (CH_2)_n . CO_2H.$$

Actually (A) was $CH_3(CH_2)_{11}CO(CH_2)_8 . CO_2H$,
(B) was $CH_3(CH_2)_{11}CO(CH_2)_4 . CO_2H$,
(C) was $CH_3(CH_2)_7 . CO(CH_2)_6 . CO_2H$,
and (D) was $CH_3(CH_2)_8CO(CH_2)_8 . CO_2H$.

No case so complex had been tried in the aliphatic series previously, and yet, from the X-ray examination of a minute amount of these compounds, Dr. Shearer was able to deduce that (A), (B), (C), and (D) have chains containing 22, 18, 16, and 19 carbon atoms respectively. Furthermore, it was possible to assign positions to the carbonyl groups in (A), (B), (C), and (D) from a consideration of the distribution of intensity among the various orders of reflection from the principal planes, and it was found that the carbonyl group is 0·52, 0·67, 0·55, and 0·50 respectively, of the whole length of the molecule from the end terminating in a methyl group. The corresponding theoretical values are 0·54, 0·65, 0·50, and 0·48, which means a maximum error of one carbon atom in placing the oxygen.

The outcome, considering the difficulties, is remarkable, and this is surely the most noteworthy invasion which the physicist has yet made of the domain of the purely structural organic chemist. The specimen (B), for example, is identical with an acid found by Bougault and Charaux (1911) in various species of Lactarius, and therefore called lactarinic acid. Its relation to stearic acid was quickly realised, but a determination of the situation of the carbonyl group involved a longer investigation. Should such a case arise again, we can replace the analytical research by an X-ray examination and confirm the conclusions by direct synthesis.

In view of the importance of the normal-chain unsaturated acids in biochemistry and their ready conversion into crystalline oxygenated derivatives, there can be little doubt that Dr. Shearer's work will find many applications even in this restricted field. On a broad view the possibilities are limitless, and gradually more and more groups of carbon compounds will become amenable to this kind of direct examination. Our more difficult problems, such as that presented by the determination of the molecular structure of strychnine, cannot be completely solved by X-ray analysis at the present time, yet, even here, Sir William Bragg has recently made a suggestion in regard to a possible utilisation of the method. It is to *stain* the molecule with heavy halogen atoms and locate these, at least in the crystal.

A different kind of use for the X-ray spectrograph in organic chemistry is illustrated by a further incident. Mrs. Robinson has synthesised the two keto-stearic acids, $CH_3(CH_2)_7 . CO(CH_2)_8 . CO_2H$ and $CH_3(CH_2)_8 . CO . (CH_2)_7 . CO_2H$, which are the possible products of hydration of stearolic acid, $CH_3(CH_2)_7 . C \equiv C . (CH_2)_7 . CO_2H$. It is stated in the literature that the addition of the elements of water to stearolic acid gives only the first-mentioned keto-stearic acid, but both synthetical acids melt at a higher temperature than does the substance derived from stearolic acid. Possibly the latter is a mixture of the two, and in order to confirm this view we had recourse to Dr. Shearer. He found that the principal spacings in the three specimens were identical, but that the intensity distributions among the different orders of reflection from the principal planes showed marked differences in the case of the two homogeneous acids, whilst the intensity distributions were intermediate in the case of the acid derived from stearolic acid. It is almost certain, therefore, that the acetylenic linkage of stearolic acid is hydrated in each of the theoretically possible directions when the substance is treated successively with sulphuric acid and water.

R. ROBINSON.

The University, Manchester.

The Structure of Stearic and Stearolic Acid.

CRYSTALS of fatty acids and similar long chain compounds are difficult to obtain in sizes large enough to give good "single crystal" X-ray photographs. Mr. W. B. Saville has succeeded in growing fairly large and thick crystals of stearic acid. They were obtained from a saturated solution of stearic acid in carbon bisulphide.

X-ray analysis shows that stearic acid crystals obtained under these conditions are monoclinic. The size of the unit cell is found to be: $a = 5·60$, $b = 7·38$, $c = 50·9$ Å.U., and $\beta = 59·7°$. The choice of the unit cell is to a certain extent arbitrary, these data give the lowest indices to the strongest reflecting planes. The density is slightly more than 1·05; this gives four molecules to the unit cell. Previous work on series of similar compounds led to the conclusion that the carbon atoms are arranged in long and uniform chains. The c axis in the present case has been put in a plane of highest density. The chain which coincides nearest with the c axis is found to be of the tetrahedral type if the diameter of the carbon atom is taken over from the diamond structure.

A single crystal of stearolic acid investigated by means of X-rays gave different photograms from those obtained from stearic acid. The symmetry is lower, and all the data seem to indicate that these crystals are triclinic. Stearolic acid has the same number of carbon atoms as stearic acid (18), but it has a triple bond in the middle of the chain.

ALEX. MULLER.

Davy Faraday Laboratory,
Royal Institution,
July 1.

Solar Activity and Atmospheric Electricity.

IN view of the footnote to Dr. Chree's article in NATURE of June 27, and an explanatory note received from him recently that his article was in type before he saw my article in the March issue of the journal *Terrestrial Magnetism*, it would scarcely be fair to him to make any comments. However, I shall be glad to send a reprint of my article to any one interested in becoming acquainted with all the points involved. Furthermore, since my March article, we have found Dr. Chree's recommendation made at the Madrid meeting of the Geophysical Union impracticable. Meteorologists have likewise not adopted his recommendation for their purposes.

We are investigating other interesting questions in atmospheric electricity, but are obliged first to recompute the early Kew observations, because Dr. Chree did not utilise concomitant observations at Greenwich. In the hope that British investigators will assist in securing the desired world-wide distribution of electric observatories during the present solar cycle, permit me to direct attention to the fact that the two observatories in Great Britain are unfavourably located, and that the only atmospheric electric observations in British oversea countries are being made in Australia and Samoa at the expense of the Carnegie Institution of Washington. Other countries are co-operating. Also, no earth current observations to our knowledge are being made under British auspices.

LOUIS A. BAUER.

Washington, D.C., June 24.

THE article by me in NATURE to which Dr. Bauer refers included a discussion of Potsdam data. These data had also been treated by Dr. Bauer in the March number of *Terrestrial Magnetism*. Dr. Bauer having sent me a copy of his article, I informed him when acknowledging it that I had also discussed the Potsdam data in an article which was already in type. I wished to make it clear—to prevent misunderstanding—that my article, the conclusions in which differed from Dr. Bauer's, was written quite independently. Beyond informing Dr. Bauer that our conclusions differed, and continue to differ, I did not tell him the substance of my article but only that of the footnote.

In the absence of information, he would seem to have supposed that the article referred to a suggestion, originally made in a presidential address to the Royal Meteorological Society (Quarterly Journal Roy. Met. Soc., vol. 50, p. 96), that a comparison should be made between the meteorological and electrical conditions on the international magnetic quiet and disturbed days. The British meteorological delegates to the meeting of the International Union of Geodesy and Geophysics, held last year at Madrid, put forward an analogous proposition, but another proposition originating from Denmark received a greater number of votes. As to the practicability of the proposition, I am naturally disposed to prefer the opinion of the meteorologists on the British National Committee of Geodesy and Geophysics to Dr. Bauer's.

In his references to the unfavourable situation, for observations on atmospheric electricity, of existing British observatories, I think Dr. Bauer must have forgotten Eskdalemuir, which unlike Kew and Greenwich is remote from any large town. He is also presumably unaware that some provision has been made for electrical observations at the new observatory at Lerwick.

We are all, I hope, aware of the energy and enterprise of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. Our only regret is that Mr. Carnegie, or some other millionaire, has not similarly endowed a geophysical institution for the British Empire.

CHARLES CHREE.

June 25.

The Sun-Clock.

I AM the fortunate custodian of a model—the only one in Great Britain—of a new kind of sun-dial, the invention of Prof. W. E. Cooke, the Government Astronomer of Sydney, N.S.W.

It is much more than a sun-dial. It is provided with a movable pointer geared to the hands of an ordinary clock-face, and by virtue of this it is aptly called the sun-clock.

At any time when the sun is shining, it is turned and directed in one simple motion, and immediately G.M.T. is read on an ordinary clock dial to within half a minute, the seasonal variations of solar time and the difference due to the longitude of the place in which it is set up being compensated for in the design of the instrument.

Reading the time on an ordinary sun-dial involves first the observation of the precise position of the edge of the shadow, which, owing to lack of definition, may be very difficult to read to an accuracy of one minute. Reference must then be made to an equation table, and whatever number of minutes are appropriate to the date must be added or subtracted in order to arrive at mean solar time. Then, to ascertain Greenwich Mean Time, a further correction is required

FIG. 1.—The sun-clock.

for the longitude of the position of the sun-dial, east or west of Greenwich.

In the sun-clock no such mental gymnastics are required. It will be seen from the illustration (Fig. 1) that instead of a gnomon, there is a pivoted brass ring the axis of which is in exactly the same plane as the gnomon would be if there was one; that is to say, its pivots lie along a line which points true north, and the angle of its tilt is equal to the latitude of the place at which it is fixed. There is a small hole on one side of the ring, well countersunk on the outside. On the inner surface of the ring, diametrically opposite to this little aperture, is engraved an analemma or graph in the form of a figure 8 to show the equation of time, or the difference between apparent and mean time, for every day in the year.

When it is desired to know the time, the ring is turned until the spot of sunlight is on the analemma. The ring is geared to the hands of a clock, and in the act of turning it they are set to G.M.T. It is not necessary to look at the date, but, incidentally, the date is there, to the very day, indicated by the spot of light, and had Robinson Crusoe been the happy possessor of a sun-clock it would have served him a

a perpetual calendar, and he need not have notched his tree.

It is said that there is nothing new under the sun, but this appears to me to be an original invention and a brilliant one.

F. HOPE-JONES.
(Chairman, British Horological Institute.)
The Synchronome Co., Ltd.,
32 and 34 Clerkenwell Road,
London, E.C.1.

The Amani Research Institute.

MAY I be allowed to add to the timely and sympathetic article on the Amani Research Institute in NATURE of June 20, p. 933, some notes on a point not emphasised by you, namely, the possibilities of Cinchona cultivation at Amani?

From the outbreak of war in 1914 Amani was used as a refuge camp for women and children, and, until its occupation by the British in 1916, its resources, thanks to the abilities of the German scientific staff, were ruthlessly exploited for the benefit of the German armies in the field. Thus, of the "economic products," catalogued under 67 heads, manufactured at the Institute, may be mentioned 830 kgm. of "plant butter" from the seeds of *Allanblackia Stuhlmannii*, 15,000 bottles of "Amani whisky" (a fearsome liquor) and medicinal alcohol, and about 400 bottles of castor oil. But most important of all were 136 kgm. of quinine sulphate, extracted at Amani, and 4000 kgm. of Cinchona bark sent to be worked up at the veterinary station at Mpapua. Prof. A. Zimmermann, the German Director of Amani, came to East Africa from Java, and brought with him both seeds of Cinchona and a knowledge of its cultivation: and the quinine plantations in the event proved one of the best investments the German Government ever made. They certainly helped materially to keep the German troops in the field. Of the three varieties of Cinchona grown in the Institute grounds—*C. Ledgeriana*, *C. succirubra*, and a hybrid (Java seed) between these two—the last assayed so well and earned so remarkable a report from the Imperial Institute that it is deserving of a wide publicity. Full details can be found in the Bulletin of the Imperial Institute, vol. 16, No. 3: I need only extract the analysis of the bark:

No. 4. *C. Ledgeriana* × *C. succirubra*.

	Per cent.
Moisture	7·50
Total alkaloid	11·30
Quinine	8·41
Cinchonidine	nil
Yield of crystallised quinine sulphate	11·21

and the manufacturer's opinion:

"The manufacturers stated that sample No. 4, the hybrid from *C. Ledgeriana* × *C. succirubra*, is one of the highest quinine-yielding barks they have examined, being fully equal to the finest Ledger bark from Java."

So far as experience has gone, Cinchona flourishes in East Africa only in the East Usambara Mountains, where the atmosphere is moist and the temperature remarkably low for the elevation (under 4000 ft.). Certainly I have not heard of its doing really well elsewhere in Tanganyika Territory, or in Kenya Colony. But in the neighbourhood of Amani there are thousands of acres of virgin forest land which appear to be suitable for Cinchona. My instructions, in view of the report on the hybrid, were to devote special attention to quinine cultivation, and when I left Amani at the end of 1923 we had some promising plantations of Ledgeriana and the hybrid (Amani seed) coming on, and, thanks to Prof. Greenish and the Director of the Wellcome Bureau of Scientific Research, some assays of the bark of known, mature hybrid trees, which confirmed the original analysis and promised to open up a tempting field of research. It had always been my hope that eventually Amani would do for the East African Colonies what Sir David Prain had done for India, and supply most of the quinine needed locally, particularly for native consumption.

ALLEYNE LEECHMAN.
(Lately Director, Amani Research Institute.)
The Bedford Natural History and Archæological Society,
Harpur Street, Bedford.

Spectroscopic Evidence of *J*-Transformation of X-rays.

IN our letter to NATURE of April 25 on spectroscopic evidence of *J*-transformation of X-rays, we pointed out that there are alternative conclusions regarding the experimental results which were taken from the Table V. given by Prof. Siegbahn in "Über die Röntgenspektren der chemischen Elemente," Jahrbuch der Radioaktivität, 1916. These conclusions are: *either* the wave-length determinations quoted are inaccurate to the extent of more than 1 per cent., *or* the discontinuities which occur in Ka_1, Ka_2, $K\beta$ are real and are due to *J*-transformation of X-rays. Prof. Siegbahn gives as his judgment that the irregularities are due to experimental error: we accept this.

The values given in the Jahrbuch are evidently those of Malmer—according to Prof. Siegbahn "not very concordant measurements" (NATURE, July 4, p. 11). At the same time Prof. Siegbahn states that Malmer's "measurements give no evidence of such a sudden change in the slope of the curve as shown in the letter of Messrs. Khastgir and Watson." We should like to point out, however, that the irregularities referred to by us have been noticed independently by J. M. Cork (*Phys. Rev.*, Feb. 1925, p. 197). Further, Günther, so late as 1924, has quoted these same values in a booklet of X-ray spectroscopic measurements, and we employed them because they constituted at that time the only available complete set of wave-lengths throughout the region where the *J*-phenomenon appears.

Mr. Nipper (NATURE, July 4, p. 12) is evidently not acquainted with the facts concerning the *J*-phenomenon (see *Phil. Mag.*, May 1925), otherwise he would not have advanced as evidence against our main contention the fact that Siegbahn's later—or for that matter, any other spectroscopist's—values do not show a discontinuity (increase in λ as Z is increased from 51 to 52). It was explicitly stated in our letter, and it has been emphasised by Barkla on many occasions, that wave-length is not the only factor which determines whether or not *J*-transformation of X-rays takes place in transmission through matter. Certain critical conditions are necessary: the character of the whole of the radiation transmitted appears to exercise a very important controlling influence (see NATURE, June 20, 1925, p. 942). The *J*-transformation evidently did not occur in the case of Siegbahn's recent determinations of wave-length, and we therefore obtain from them no evidence of the *J*-phenomenon.

S. R. KHASTGIR.
W. H. WATSON.
Physical Laboratory,
University of Edinburgh,
June 19.

The Cresswell Engravings.

MR. J. WILFRID JACKSON, in his letter to NATURE of June 6, p. 874, refers to the occasion when he first saw these engravings and says, "I also told him it was a mistake to outline the figures in chinese white." I am quite sure Mr. Jackson did not intend it to be so, but, none the less, this is a misleading statement and open to a wrong interpretation. The engravings were not outlined in white, and only one specimen, the reindeer piece, has ever been so outlined. This example is executed in very fine, thin, lines upon bone afterwards scorched black by fire, hence the drawing is not readily seen unless the bone is held at the correct angle. For photographic purposes chinese white was *rubbed* into the lines, as a satisfactory picture could not be obtained otherwise.

Sir William Boyd Dawkins asked me to send the engravings to him for inspection, and photographs were sent with them. As an act of courtesy, the reindeer piece was forwarded in the condition in which photographed, and my covering letter expressly pointed out that it was sent thus outlined to assist him in his examination and that the outlining could be removed immediately by the application of a sponge or damp handkerchief. As neither he nor Mr. Jackson took the trouble to do this, they are scarcely in a position to express a trustworthy opinion upon the character of the lines composing the figure. Had they done so, they would have seen at once that the lines are clean, sharp, continuous cuts, and bear no resemblance whatever to the half-tunnels formed by roots. Mr. Jackson's interpretation of certain selected markings upon an ancient skull are interesting, but no one familiar with the technique of Palæolithic art could mistake these broken lines upon the portion he illustrates for the handiwork of man.

The authenticity of the engravings from Mother Grundy's Parlour, Cresswell, is testified by the authorities at the British Museum, by Mr. Miles C. Burkitt of Cambridge, the foremost British authority on Palæolithic art, Prof. Sollas, and others. The considered opinion (with full knowledge of Mr. Jackson's objection) of M. L'Abbé Breuil relative to the specimens was reported in NATURE of May 2, p. 658.

A. LESLIE ARMSTRONG.

14 Swaledale Rd.,
Sheffield, June 25.

Ancient Science.

PERMIT me to supplement two passages in NATURE of June 20.

P. 963, *Accuracy of Weighing in the Eighth Century*.—In 1885 I found a hoard of fifty-eight Athenian tetradrachms of uniform type and unworn condition. I reduced the chloride on each by means of zinc, and so obtained the original weights. The average was 264·2 grains, with a mean variation of 0·6 grain. Thus 4/5 of the coinage of Athens would have passed the remedy of the Mint in modern England. This must evidently have been the result of careful weighing and adjustment. In a group of small Gaulish silver coins, from Chalons-sur-Saône, which I bought in Paris, the average is 29·85 grains and the mean variation 0·33 grain, so it is evident the balance was used in Gaul. Weights are found in prehistoric Egypt so far back as 8000 B.C.

P. 937, *Egyptian Mathematics*.—The most frequent kind of problem in the Egyptian mathematical papyrus, that of dividing a stock of food, seems to be the origin of their fractional system. If 2 loaves have to be divided among 7 people, the obvious way is to divide the stock into 8 parts, distribute 7, and divide the remaining quarter of a loaf into 7 parts. Thus 2/7 naturally becomes 1/4 + 1/28. The same system was used in dividing the profits of Scotch fishing-boats. The master served out a pound to himself, a pound to each of his crew, and a pound for the boat. When there were not enough pounds to go round, the remainder was changed into half-sovereigns, the next remainder into half-crowns, then shillings, then pence, and finally sweeties. The system seems obvious in all cases where written accounts were not prepared.

FLINDERS PETRIE.

5 Cannon Place, Hampstead, N.W.3.

On the Daily Use of an Immersion Condenser.

IN daily observations on the structure of chromosomes fixed and stained in iron-acetocarmine (see *American Naturalist*, 1921, pp. 573-574), where the limit of resolution in the microscope must be maintained, it has been determined that water is, on the whole, to be preferred to cedar oil as an immersion fluid for the condenser. The corrections necessary are readily made. (1) By centring a large enough meniscus lens from a photographic camera below the condenser (Hartridge); and varying the distance of the light source, and the thickness of the object slide, until the best image of a grating close to the light source is obtained. (2) By unscrewing sufficiently the top lens or lenses of the condenser. Slides can easily be selected of approximately the required thickness. The test for aplanatism is, of course, to diaphragm the source of light until its image is equal to or smaller than the field of view, and then observe the light circle at the back of the objective.

Cells in iron-acetocarmine become plastic after a certain time, and can be squeezed flat by slight pressure. When the chromosomes are thus spread out in contact with the cover-glass there is a good opportunity to seek for possible visibility of the chains of genes, either with the Watson dark field condenser of 1·3-1·4 aperture, or with the arc and two tourmalines, as mentioned by Beck in his lately published manual.

JOHN BELLING.

Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor, L.I.,
New York.

The Faraday Benzene Centenary and Kekulé.

IN connexion with the benzene centenary, it may perhaps be pointed out that the name Kekulé is not French. August Kekulé, born in Darmstadt (1829; he died in Bonn, 1896), was a descendant of Wilhelm Dionysius Kekule (or Keckhule) von Stradonitz, who came from Bohemia in the seventeenth century. The é was probably adopted to guard against the suppression of the final e; that has been done in other cases. August Kekulé himself spelt his name with é, even in his earliest papers, before he went to Ghent and Bonn, and still in 1890, when his researches on the construction of aromatic compounds and the twenty-fifth anniversary of his benzene-hexagon (Bonn, 1865) were commemorated by an international Kekulé celebration at Berlin. But he had by that time (1890) resumed the full name A. K. von Stradonitz. The present members of the family spell their name without the accent.

H. BORNS.

Chiswick, June 30.

Ether-Drift Experiments at Mount Wilson.

By Prof. DAYTON C. MILLER, Case School of Applied Science, Cleveland, Ohio.

THE Michelson-Morley experiment for determining the relative motion of the earth and the luminiferous ether, the "ether-drift experiment," was first performed in Cleveland in the year 1887, by Prof. Albert A. Michelson and the late Prof. Edward W. Morley. The theory of the experiment and a description of the apparatus was published in the *Philosophical Magazine* for 1887, and has been repeated in many text-books since that time. They announced their conclusions as follows: "Considering the motion of the earth in its orbit only . . . the observations show that the relative motion of the earth and the ether is probably less than one-sixth the earth's orbital velocity and certainly less than one-fourth." (That is, it is less than 7·5 kilometres per second.) This result was considered by many as a null result, often called a negative result, and by some was thought to throw grave doubts upon the validity of the hypothesis of the luminiferous ether.

At the International Congress of Physics, held in Paris in 1900, Lord Kelvin expressed the conviction that the experiment should be repeated with a more sensitive apparatus. The present writer, in collaboration with Prof. Morley, constructed an interferometer about four times as sensitive as that used in the first experiments, having a light path of 224 feet, equal to about 150,000,000 wave-lengths. In this instrument a relative velocity of the earth and ether equal to the earth's orbital velocity would be indicated by a displacement of the interference fringes equal to 1·5 fringes. This apparatus was used in the basement of the Physical Laboratory of Case School of Applied Science in Cleveland, observations being made in 1904 and 1905. The result of these observations was published in the *Philosophical Magazine* for May 1905, as follows: "We may, therefore, declare that the experiment shows that if the ether near the apparatus did not move with it, the difference in velocity was less than 3·5 kilometres per second unless the effect on the materials annulled the effect sought. Some have thought that this experiment only proves that the ether in a certain basement-room is carried along with it. We desire, therefore, to place the apparatus on a hill to see if an effect can be there detected."

In the autumn of 1905 Morley and Miller removed this interferometer from the college laboratory to a site on Euclid Heights, Cleveland, at an altitude of 300 feet above Lake Erie and free from obstruction of buildings. Five preliminary observations were made which gave indication of a positive effect as of an ether-drift of about one-tenth of the then expected drift. We were compelled to discontinue these experiments by circumstances beyond our control, before any definite results could be obtained.

The indication of a small positive effect made it seem necessary to continue the experiments, but it was thought desirable that further observations should be carried out at a much higher altitude. Prof. Morley retired from active work in 1906 and the continuance of the observations was long delayed. The suitable opportunity for continuing the experiments came in 1921, and upon the invitation of Prof. George E. Hale, Director of the Mount Wilson Observatory in California, the interferometer which had been used in 1905 was remounted at the Mount Wilson Observatory. Four distinct groups of observations have now been made in this location: in March and April 1921, in November and December 1921, in August and September 1924, and in March and April 1925. The first observations at this Observatory gave a definite, positive result considerably larger than that previously obtained in Cleveland, being equal to about one-third of the earth's orbital velocity.

On the simple theory of the ether-drift experiment, it is presumed that the system of interference fringes which is observed will suffer a periodic displacement as the interferometer is rotated in the horizontal plane, this displacement being proportional to the relative motion of the earth and the ether. The rotation of the earth on its axis causes the plane of the interferometer to move as though it were on the surface of a cone the axis of which coincides with that of the earth, and thus to take many different space orientations. It is only that component of the actual drift which lies in the horizontal plane of the interferometer at the moment of observation which can be observed. Therefore, the *apparent* azimuth and magnitude of the drift should change with the time of observation. A drift perpendicular to the plane of the interferometer will produce no effect whatever; it is quite possible that this condition may occur at certain times of the year.

It was suggested that the small observed effect might be due to magnetism acting on the steel frame of the interferometer, or that it might be due to radiant heat or other instrumental disturbances. The trying out of the various suggestions has involved continuous experimentation during the last four years, in which time every suspected cause of disturbance has been investigated, and it has been shown that none of these causes is responsible for the observed displacement.

In the summer of 1921 the steel frame of the interferometer was dismounted and a base of one piece of concrete reinforced with brass was cast in place on the mercury float. All the metal parts were made of aluminium or brass; thus the entire apparatus was free from magnetic effects and the possible effects due to heat were much reduced. In December 1921, 42 sets of observations consisting of 900 single measures of the drift were made with the non-magnetic interferometer. These show a positive effect as of an ether-drift which is entirely consistent with the observations of April 1921. Many variations of incidental conditions were tried at this epoch. Observations were made with rotations of the interferometer clockwise and counter-clockwise, with a rapid rotation and a very slow rotation, with the interferometer extremely out of level, due to the loading of the float on one side. Many variations of procedure in observing and recording were tried. The results of the observations were not affected by any of these changes.

The entire apparatus was returned to the laboratory

in Cleveland. During the years 1922 and 1923, many trials were made under various conditions which could be controlled and with many modifications of the arrangements of parts of the apparatus. An arrangement of prisms and mirrors was made so that the source of light could be placed outside the observing room, and a further complication of mirrors was tried for observing the fringes from a stationary telescope. Methods of photographic registration by means of a motion picture camera were tried. Various sources of light were employed, including sunlight and the electric arc. Finally, an arrangement was perfected for making observations with an astronomical telescope having an objective of five inches aperture and a magnification of fifty diameters. The source of light adopted was a large acetylene lamp of the kind commonly used for automobile headlights. An extended series of experiments was made to determine the influence of inequality of temperature and of radiant heat, and various insulating covers were provided for the base of the interferometer and for the light path. These experiments proved that under the conditions of actual observation, the periodic displacement could not possibly be produced by temperature effects. An extended investigation in the laboratory demonstrated that the full-period effect mentioned in the preliminary report on the Mount Wilson observations is a necessary geometrical result of the adjustment of mirrors when fringes of finite width are used, and that the effect vanishes only for fringes of infinite width, as is presumed in the simple theory of the experiment.

In July 1924 the interferometer was taken again to Mount Wilson and mounted on a new site where the temperature conditions were more favourable than those of 1921. The interferometer house was also mounted with a different orientation. Again the observations showed a definite positive effect corresponding to the observations previously made at Mount Wilson. The observations on Mount Wilson were resumed in March 1925, and continued until about the middle of April, during which time 1600 measures of the drift were made. Again many variations in detail of arrangement of parts and in methods of observing were made without in any way altering the result. Throughout the latter epoch of observations the conditions were exceptionally good. The observations of April 1925 give results almost identical with those of April 1921, notwithstanding that the interferometer had been rebuilt and that a different system of illumination and different methods of observation were employed, and that it was mounted on a new site in a house differently oriented.

The interferometer readings being plotted, give directly by harmonic analysis the azimuth and magnitude of the ether-drift. There are no corrections of any kind to be applied to the observed values. In the work so far, every reading of the drift made at Mount Wilson has been included at its full value; no observation has been omitted because it seemed to be poor and no "weights" have been applied to reduce the influence on the result, since no assumption has been made as to the expected result. It may be added that while the readings are being made, neither the observer nor the recorder can form the slightest idea as to whether any periodicity is present, much less as to the direction or amount of such periodicity.

The ether-drift experiments at Mount Wilson during the last four years, 1921 to 1925, consisting of about 5000 single measures of the drift, lead to the conclusion that there is a positive displacement of the interference fringes, such as would be produced by a relative motion of the earth and the ether at this Observatory, of approximately ten kilometres per second, being about one-third of the orbital velocity of the earth. By comparison with the earlier Cleveland observations, this suggests a partial drag of the ether by the earth, which decreases with altitude. A more extended account of these observations is given in the Proceedings of the National Academy of Sciences for June 1925.

Dr. Ludwik Silberstein, in his letter to NATURE of May 23, has pointed out that these results, indicating a partial drag of the ether by the earth, "are easily explicable by means of the Stokes' ether concept, modified by Planck and Lorentz," as discussed in a paper by Silberstein in the *Philosophical Magazine* for February 1920.

The final test of these observations is whether they lead to a rational and wholly consistent indication of a constant motion of the solar system in space, combined with the orbital motion of the earth and the daily rotation on its axis. There is a specific relation for a given latitude between the observed azimuth of drift and the sidereal time of observation. Observations at different sidereal times should show different azimuths, and all observations at the same sidereal time should show the same azimuth for a given epoch. It is believed that a reconsideration of the Cleveland observations, from this point of view, will show that they are in accordance with this presumption, and will lead to the conclusion that the Michelson-Morley experiment does not and probably never has given a true zero result. A complete calculation of the observations now in progress, together with further experiments to be made in the immediate future, should give definite indications regarding the absolute motion of the solar system in space.

The Science Exhibition at Wembley.

THE Science Exhibition arranged by a Committee of the Royal Society in the Government Pavilion at Wembley represents a great advance on the similar exhibition held last year, particularly as regards the section devoted to physics. The space available has been considerably extended and the equipment of the demonstration benches is much more adequate. Perhaps the most striking advance, however, is the admirably systematic manner in which it is now possible to present the exhibits, for these have been arranged on an underlying plan which gives unity to the whole and converts a collection of miscellaneous experiments into an orderly sequence of demonstrations, which are not only striking in themselves but also calculated to give visitors a very fair impression of the nature of modern physics and the scope of the problems to which it addresses itself. The key to this part of the exhibition is to be found in an enormous chart, some 24 ft. long

showing the wave-lengths of electromagnetic radiation as a continuous series according to a logarithmic scale, the general nature of the radiation and the methods by which it is detected and generated being shown against each range of wave-lengths. This chart itself, which covers 60 octaves, is of considerable interest, particularly as regards the regions of overlap. For example, it has in recent years become possible to generate and detect radiation the wave-length of which is a few tenths of a millimetre both by thermal and by electromagnetic methods. It is a remarkable fact that it is now possible to use a scale of wave-lengths as a guide to a very representative series of physical experiments: it emphasises the change which has taken place in the orientation of scientific thought since the days when matter was everything and energy had not been defined, for now energy is paramount and matter is mentioned as an afterthought.

Bearing in mind the general scheme indicated by the chart, the visitor is conducted along a series of excellently appointed benches designed to illustrate the properties of the various types of radiation, beginning with the shortest. He is first introduced to the atom, as the source of gamma radiation, and this is represented by some new models in addition to apparatus which will be familiar to physicists. On the ceiling the relative distances of the electrons and nucleus in a neon atom are shown by means of coloured lamps, and further models, for which Prof. W. L. Bragg and Mr. D. R. Hartree are to be responsible, are awaited with interest. Another striking exhibit connected with atomic structure is an apparatus from the Clarendon Laboratory in which a single particle at a time, emitted by polonium, is made to break down the resistance of a small spark gap, the resulting current being made audible by means of amplifiers and a loud speaker. The properties of gamma rays are illustrated by a projection electroscope contributed by Dr. E. A. Owen, the rate of discharge being varied by placing various screens in the path of gamma rays emitted by radium.

Amongst the experiments connected with X-ray apparatus may be noted a very fine demonstration due to Mr. F. D. Edwards of the electric discharge through air at gradually decreasing pressure in a tube 4 ft. 6 in. long. The large scale of the apparatus makes these always beautiful effects very striking, and the rise in resistance of the tube at the highest and lowest pressures is indicated by sparks across a 10-inch alternative gap. A less familiar demonstration is afforded by de la Rive's apparatus, in which a luminous arc passes from an electrode at the top of a discharge tube to a ring electrode at the bottom, the core of an electromagnet being located in the axis of the ring. The arc is seen to rotate in one direction or the other according to the polarity imparted to the electromagnet. Dr. G. W. C. Kaye contributes a soft X-ray apparatus with which visitors can study the transparency of various substances by the aid of a fluorescent screen, and there are exhibits illustrating the application of X-rays to crystal structure. Bridging the gap between X-rays and ordinary ultra-violet light we have the Schumann X-rays, produced by the impact of electrons the velocity of which is measured by some hundred volts, and detected by their photo-electric effect on the insulated electrode of an electrometer. It was in this region that the "death-ray" was alleged to lie.

The ultra-violet range is illustrated by several demonstrations of which the most intriguing is perhaps one due to Sir Herbert Jackson, in which mixed visible and ultra-violet rays from a condensed aluminium spark are focussed by a quartz lens on a screen which fluoresces to ultra-violet rays of wave-length 1850 or 1860 Å.U. The visible rays are found to be focussed at about 2 ft. from the lens and the ultra-violet of the above wave-lengths at about 8 inches, so that by moving the screen it is possible to find two differently coloured focal regions. Mr. Guild contributes a visible spectrum projected by means of a calcite prism. The existence of radiation beyond the visible spectrum is shown by means of a thermopile at one end and a zinc sulphide screen at the other, and the effect of interposing various colour filters is shown by a comparison of the filtered spectrum with a patch of otherwise white light which has passed through the filter. Dr. Curtis shows that on increasing an electric discharge through nitrogen by shunting the break of the induction coil with a condenser, the disruption of the nitrogen molecules changes a band spectrum into a line spectrum, and a similar contrast is obtained by Prof. Fowler by means of a flame arc containing calcium fluoride, the band spectrum due to the fluoride being accompanied by a line spectrum due to the dissociated elements. Prof. Horton and Dr. Ann Davies illustrate the nature of light emission with an apparatus for showing excitation potentials, and there are photoelectric cells in action contributed by the Clarendon Laboratory and Mr. T. H. Harrison. Interference phenomena in the visible range are represented by a Michelson interferometer (Mr. Twyman), Lippmann colour-photographs (Mr. Gamble), diffraction gratings from the National Physical Laboratory (Mr. J. S. Clark), and a demonstration due to Prof. Rankine of the projection of an image of a luminous object by means of a spherical bicycle ball in place of a lens. Each point in the object throws a circular shadow of the ball having a white spot at its centre, and the aggregate of white spots forms the required image. Photographs can be reproduced by this method. Polarisation apparatus is shown by Prof. Cheshire.

For the infra-red region Mr. Twyman has a spectrometer with a rock-salt prism which can be turned by a micrometer screw so as to traverse the spectrum across a thermopile. The spectrum from 5,000 to 100,000 Å.U. can be explored in this way, and a Bunsen burner is shown to emit strongly in the neighbourhood of 44,000 Å.U. A caesium photo-electric cell, which is sensitive to infra-red rays, is contributed by the Clarendon Laboratory, an ebonite screen serving to filter out the visible light. The transition to wireless wave-lengths is afforded by Mr. F. E. Smith's demonstration of the production and heating effects of very short Hertzian waves, and by Sir William Bragg's example of Lindman's apparatus for rotating the plane of polarisation of such waves by means of an arrangement of metal spirals, the action being similar to that of quartz and other crystals which are optically active in the visible region.

The interest of the non-scientific visitor, for whose benefit the Exhibition is primarily intended, will no doubt be specially caught by the display of wireless

apparatus, of which a few examples only can be mentioned. The Lecher wires (Prof. Whiddington) will illuminate the conception of wave-length, and apparatus by Dr. Smith-Rose demonstrates the rectifying property on which crystal detectors depend. The determination of absolute frequency by Mr. D. W. Dye's recently perfected oscillograph system is also a feature in this section of the Exhibition. The cathode-ray oscillograph is caused to give a circular trace by means of crossed fields controlled through a valve by a standard tuning-fork, the ray completing the trace once per vibration of the fork. By the superimposition of a supplementary pair of crossed fields at high frequency the circular trace is transformed into a closed series of loops when the frequency is a harmonic of the fork frequency, and can be calculated from that and the number of loops. In this way standardised high frequencies can be obtained. The same apparatus is used to give wave form by transforming the circle into a long ellipse, and adding to the deflecting field which gives the minor diameters a further deflecting field proportional to the high frequency voltage. If the eccentricity of the ellipse be sufficient, the time base is substantially rectilinear and uniform. Direction finding is demonstrated by Dr. Smith-Rose, the currents produced in a rotatable coil by a neighbouring oscillator being read off from a galvanometer. Possibly if a pointer were fixed to the coil with its tip moving over a set of equidistant straight lines forming a scale, the galvanometer reading could be adjusted to give directly the sine of the inclination of the coil to the wave front, as indicated by the tip of the pointer. The General Electric Company illustrates in a striking way the problem of uneven filament-heating. In a diode valve the filament heating current is an A.C. from the source that supplies the anode volts, but the phase of the filament current can be varied. The brightest point on the filament is seen to move along the latter as the phase alters. The longest electromagnetic wave-lengths are represented by some experiments on audio-frequency currents.

Amongst the geophysical apparatus must be mentioned a working installation of the new Milne-Shaw seismograph, which employs an optical lever and Foucault-current damping. This instrument is exceedingly sensitive, giving a magnification of 500, and can even indicate the tilt of a coast due to tidal load. Records of the Japanese earthquake of September 192 are exhibited.

The biological exhibits include all those which proved most attractive last year together with some additions, amongst which may be mentioned Prof. Groom's cultures of various species of fungus causing dry-rot in timber. Prof. Harris shows an apparatus for measuring the oxygen pressure of fresh blood, the blood and a comparison solution being contained in two quartz bottles which can be exposed to light containing ultra-violet radiation. It is shown that exposure to light promotes the absorption of oxygen and so alters the equilibrium point between the oxygen in the blood sample and that in the air above it. Dr. E. H. Schuster shows a respiration pump by means of which a detached organ or a headless trunk can be kept alive for some hours. In connexion with physiological demonstrations it is perhaps well to remind the public that with a few rare exceptions British biologists have been humane men who have recognised the imperative duty of using anaesthetics in experiments on living animals. In the physiological section is also classified an apparatus for measuring the compressional elasticity of films of fatty substances on water. The water surface is swept clean and the film is compressed by means of a measured force applied to a floating strip. The films are found to be monomolecular. The method has been used for estimating very small amounts of fat.

An attractive innovation is a miniature kinematographic projector by Kodak for which a number of scientific films have been obtained, including some high speed films taken with the Heape and Grylls machine.

The Exhibition as a whole is an admirably conceived attempt to instruct the public as to the methods and aims of science, and is entitled to the support of all who have the interests of scientific prestige at heart. In conducting their unscientific friends through the series of demonstrations provided they will themselves derive no small profit and enjoyment. C. W. H.

Problems of the Rhone Delta.[1]

By R. D. OLDHAM, F.R.S.

III.

THE eastern branch of the Rhone has undergone changes, as extensive and remarkable as those of the western, though differing in character. In the early centuries of our era the mouth of the river is put, in the maritime itinerary of the Antonines, at 16 Roman miles from the port of Fossæ Marianæ, and from thence it was 30 miles by river to Arles. These distances fix the mouth of the river close by the present termination of the Vieux Rhône, or main channel during the seventeenth century, and this identification is borne out by the finding, in 1883, of an old boundary pillar with a Latin inscription, regarded as fifth or sixth century, which appears to show that it was set up near to the mouth of the Rhone. The place where it was found lies 3 km. west of the old river channel and 2 km. inland from the sea-face of the delta, and, whatever may be the exact age of this inscription, it must date from before the subsidence in the Dark Ages.

This subsidence brought about great changes; a large part of the seaward portion of the delta was submerged, leaving numerous islands of various sizes, the memory of which is partially preserved in local place names, and the mouth of the river proper receded to near, but not up to, the town of Arles.

When light again begins to dawn on the history of this region we find, in the description, by Roger of Hoveden, of the voyage of an English fleet along the coast in 1190, a statement that they passed an island called Odur, at the mouth of the Rhone, going up which river brings one to the fine city of Arles le Blanc. The identification of this Odur is certain; it is known at the present day as the Roque de Dour, or more simply

[1] Continued from p. 19.

Roque, a low hill of about 25 feet high, rising from the alluvium of the delta, just west of the entrance to the Étang de Galéjon. In the form of Odor or Dor it appears on all the portolan maps, being given equal prominence with other more conspicuous towns, ports or landmarks, and evidently owed this prominence to its importance as marking the entry to the main channel leading to Arles. On a flat, low-lying coast, often indistinguishable in hazy weather, even so small a hill would form an important landmark.

The course of this channel can still be traced; it was up the Étang de Galéjon, and then westwards along the general course of an old river channel, known as the Bras Mort, to the neighbourhood of the village of Passon, on the banks of the Rhone. Along this line there is a strip of low-lying modern alluvium, bordered on both sides by higher ground, part of the old land surface of the Roman period. The Bras Mort was practicable for small boats, at any rate during part of the year, until it was artificially closed in 1642, but long before that it had ceased to be navigable by ships. The channel was, however, still in use at the beginning of the fifteenth century, and is described in a portolan, or book of sailing directions, printed at Venice in 1490, evidently from old manuscripts works of similar character, dating from the early part of the century.

The advance of the mouth of the river and successive closing of alternative channels of access to the town and port of Arles can be traced in the records of that city. From the commencement of the Middle Ages it claimed, and exercised, a control over the navigation of the Rhone, and, for the purpose of this control, maintained an armed and fortified post for the double purpose of levying tolls on the shipping and excluding undesirable, or piratical, intruders. The latter purpose made it desirable that the post should be as distant as possible from Arles itself; the former compelled it to be situated so near that the traffic had to pass it, that is to say, above the highest point where there was an alternative channel to the open sea. The earliest of these fortified posts or towers of which there is record was the Tour de Malusclat; the exact position of this has not been identified, but the name remains as that of a village, and it must have been on the western bank of the river a couple of miles or so above Passon, the place where the old channel from the Galéjon joined what is now the main stream of the Rhone. The date of construction of this tower is not known, but, about the middle of the fifteenth century, the advance of the mouth of the river having reached the neighbourhood of Passon, the channel leading to the Étang de Galéjon, and the Roque de Dour, became blocked by the alluvial deposits of the river, thereby closing what had been the principal channel of access. This made the situation of Tour de Malusclat no longer suitable, and, in 1469, the Council of Arles decided that it should be demolished and a new tower built farther down the channel.

The site of this new tower, afterwards known as the Tour de Belvar or Bolovard, has been identified, in the lands of the Grand Peloux, close to the left bank of the present channel, and nearly opposite where the Bras de Fer channel takes off from the river. It was not, as has been stated in some modern works, built on the actual sea-face of the delta, for maps of the seventeenth century, and records of law suits and grants of land in the thirteenth, show that there was land to the southwards, but the site was chosen because it lay at the junction of two alternative channels of access, and was the site, farthest from the city of Arles, at which the whole traffic of the river could be controlled by a single post. It remained in function for more than a century, during which the principal channel led southwards, much along the general course of the existing river channel. By 1587 the mouth of the river proper had advanced to this place, and the river, instead of continuing along the direct channel, broke away to the westwards, to follow the general course of the Bras de Fer.

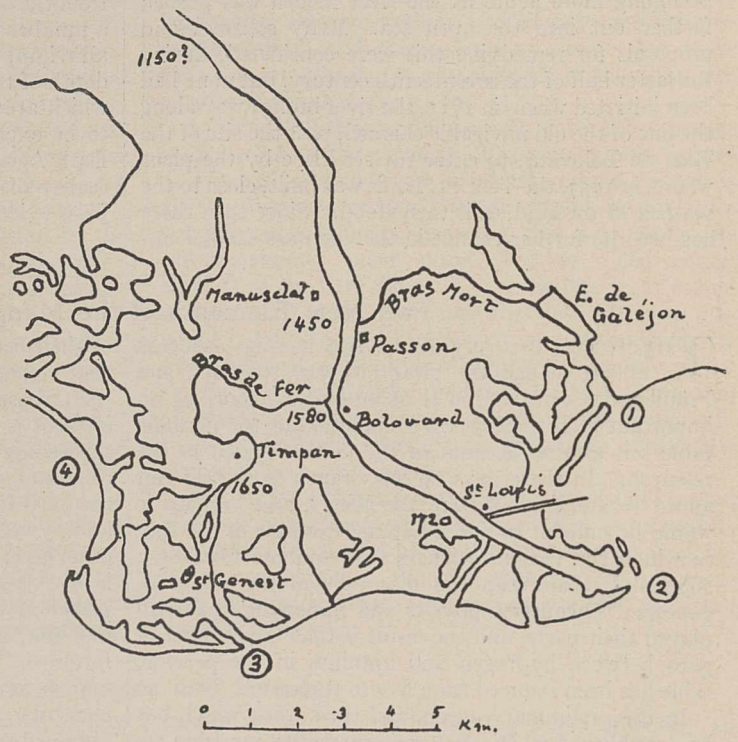

FIG. 4.—Lower course and mouth of the Rhone, showing position of the successive towers, approximate position of the mouth of the river at the dates indicated, and main channels of navigation. (1) Up to about 1450. (2) Until 1585 and again from 1720 to the present day. (3) From about 1585 to 1720. (4) Alternative channel, finally blocked about 1650.

The Tour de Bolovard was thus left stranded and, after a while, sold and demolished, all but the foundations, which still remain. Meanwhile, a new tower had been built, in 1607, known as the Tour de Tampan, on the banks of the Vieux Rhône, and about 8 km. inland from the present coast-line. Here, again, the tower was not built on the sea-face, for old maps show that a group of islands, separated by channels, extended out to very near the existing sea-face of the delta; the site was evidently selected because, in addition to the channel afterwards followed by the river, there was another navigable channel, called the Rajeirol, which led, from a little below the tower, into the Golfe de Beauduc.

In course of time the river mouth passed this channel and blocked it up, so the Tour de Tampan was abandoned and a new one, the Tour de St. Genest, was built, in 1656, on what was evidently an island of the old land surface of Roman times, and not far from the spot where the boundary stone with Latin inscription was discovered in 1883.

This tower, at last, lay close to the sea-face of the delta; the most advanced outpost of the old land was not much more than a mile to the southwards, and, when the river extended past this point, it no longer ended in a sheltered inlet, but in the open sea. The formation of an extension of the delta, by the silt brought down the river, began, and a difficult and dangerous bar developed, the hindrance to navigation becoming more acute as the river mouth was pushed farther out into the open sea. Many schemes and proposals for remedying this were considered, during the latter half of the seventeenth century, but none had been initiated when, in 1711, the river broke away along the line of the old navigable channel, past the site of the Tour de Bolovard, to enter the sea close by the place where, in 1737, the Tour St. Louis was built, close to the sea-face of the land, as it then stood. Since then there has been no further change in the channels farther up-stream, and the whole river is so firmly contr by protective embankments that none is likel occur.

From this brief history it appears that the mou the Rhone, which was near Passon about the mi of the fifteenth century, had advanced to the pre coast-line at the Vieux Rhône by the middle of seventeenth, and early in the following century wa the coast-line of that time near the modern tow St. Louis. This advance of the mouth of the river not, however, mean a growth of the delta by a dep ten kilometres along a breadth of about twenty; would mean an increase of nearly a square kilome year, fully five times the rate of growth of the during the last two centuries. It was, however, from the open sea that the land was reclaimed, but a number of shallow channels separating islands o alluvium, thus reducing largely both the area depth of the new deposits, and in this way the chan which are known to have taken place, are not me to be explained by subsidence of the land during Dark Ages, but in themselves become evidence of reality of the change of level, independently ded from evidence of a wholly different character.

(*To be continued.*)

Two New Elements of the Manganese Group.

THE recent discovery of the two missing elements of the manganese group by Dr. Noddack and Fräulein Tacke of Berlin is of interest not only as an important step towards the completion of the periodic table but also on account of the methods used in the research. In these days no one branch of science can afford to stand aloof from the others, and perhaps it would be difficult to find a happier example of the way in which the various sciences can combine towards a successful result than this discovery of the eka-manganeses. Chemistry, physics and mineralogy have all played their parts, and the result is that the number of gaps between hydrogen and uranium in the periodic table has been reduced from five to three.

In the preliminary account of their work which has been published in *Die Naturwissenschaften* for June 26, p. 567, the authors give, in addition to the results of their investigations, the arguments on which their line of attack was based. In the first place, it was necessary to find some material in which the new elements might reasonably be expected to occur. A study of the neighbouring elements suggested two possible sources; the first that of the platinum ores, the second a mineral such as columbite. The platinum ores contain the elements chromium to copper, ruthenium to silver, osmium to gold, or, expressed in atomic numbers, 24 to 29, 44 to 47, and 76 to 79. Columbite, on the other hand, contains, among many other elements, those of atomic number 39 to 42 and 71 to 74. Here, therefore, were two minerals in either of which the missing elements 43 and 75 might well be found.

In endeavouring to form an estimate of the amounts of the elements 43 and 75 which might be present in these minerals, the authors employed an ingenious argument. The constitution of the earth's crust is now fairly well known, and it is possible to assign to the various elements numbers indicating the frequency of their occurrence. A study of these figures indic that elements of odd atomic number are less com than those of even atomic number; in fact, an element is ten or twenty times less abundant than succeeding even element. As ruthenium (44) osmium (76) constitute about 2×10^{-12} and $2 \times 10^{-}$ the earth's crust, it was deduced that the element and 75 would form about 10^{-13} and 10^{-12} of the ear outer layer. As the frequency of occurrence of platin is 10^{-9}, the amount of the elements 43 and 75 in platinum ores should be from 10^{-3} to 10^{-4}, and niobium, one of the chief constituents of columb forms 10^{-7} of the earth's surface, columbite was mated to contain from 10^{-5} to 10^{-6} of the mis elements. In this way Drs. Noddack and Ta obtained some idea of the extent to which the chem processes of extraction would have to be carrie measurable quantities of the new substances were t obtained.

It was a fairly straightforward matter to predict s of the chemical properties of the new elements fro consideration of their neighbours in the periodic ta Thus it appeared probable that both would form oxi X_2O_7, and that these oxides would readily sublim account of the small difference of temperature betw their melting- and boiling-points. Again, for exam it was argued that the eka-manganeses would resem chromium in so far as no sulphides would be for from aqueous solutions. These and other chemical perties were used in the chemical treatment of the

Attention was first directed to the platinum ore offering the highest chance of success. After liminary chemical treatment, the residue of 80 gr a Russian ore was strongly heated alternately in oxy and hydrogen. Among the deposits on the walls o vessel was found a very small quantity of white mi scopic needle crystals. These needles became dar

colour when treated with a stream of hydrogen sulphide, while a subsequent heating in oxygen resulted in the reappearance of the white sublimation product on the colder part of the vessel. An aqueous solution of these crystals gave no precipitate either with hydrogen sulphide or ammonium sulphide. As such behaviour was to be expected from the elements 43 and 75 and from none of the other known elements in the solution, it was presumed that this substance contained the missing elements. Further attempts at concentration resulted in a loss of the material.

Through lack of further supplies of the platinum ores, the authors turned their attention to columbite, resolving at the same time to carry out the final analysis by X-rays. From about 1 kgm. of the mineral the greater part of the iron, niobium and tantalum was removed by sodium hydroxide and sodium nitrate; the filtered solution was treated with hydrogen sulphide and concentrated to a volume of 50 c.c. By the use of mercurous nitrate, about one gram of precipitate was obtained from this solution. A repetition of the process gave about 50 mgm., estimated to contain about 5 per cent. of the elements 43 and 75. Heating in oxygen gave once more the white sublimate. The quantity available was too small for direct application to the anticathode of the X-ray tube. It was, therefore, mixed with niobic acid and examined spectroscopically in this form.

X-ray spectra probably provide the best method for the detection of a small quantity (say 0·1 per cent.) of an element in a mixture. These spectra are much simpler in nature than the optical spectra, and, unlike the latter, do not depend on the mode of excitation or on the state of chemical combination. The wave-lengths are determined by the atomic number alone. From Moseley's laws it is possible to predict the wave-lengths of the various lines with considerable accuracy. A further check is provided by an examination of the relative intensities of the lines. An X-ray investigation of the final products of the chemical processes was carried out by Drs. Berg and Tacke, and a search made for the K series of the element 43 and for the L series of 75. The result was entirely successful. Three lines appeared on the plates corresponding to wave-lengths 0·601, 0·672 and 0·675 Å.U., whereas the calculated values of the $K\beta_1$, Ka_1 and Ka_2 lines for an element 43 are 0·600, 0·673 and 0·678 Å.U. These are the three strong lines in the K series, and their relative intensities agreed with the well-known ratios. In the spectral region 1·20 to 1·43 Å.U. there occurred five lines which were identified as the La_1, La_2, $L\beta_1$, $L\beta_2$ and $L\beta_3$ lines of an element of atomic number 75. The numerical agreement was excellent; thus, the observed and calculated wave-lengths of the La_1 line were 1·4299 and 1·4306 Å.U. There is always a chance that the lines may be wrongly identified, but the authors appear to have taken due precautions against any possible misinterpretation, and there seems no doubt that these lines are actually due to the presence in the columbite residue of the elements 43 and 75.

As a result of this careful research work, the existence on the earth of the elements of atomic number 43 and 75 appears to be definitely established, a fact which is all the more interesting because certain writers have put forward arguments suggesting that a search for the eka-manganeses must prove fruitless. The actual amount of the new elements in columbite is estimated as from 10^{-6} to 10^{-7}, or somewhat less than the proportion indicated by the calculations outlined above. The chemical and physical properties appear to be closely related to those predicted by an examination of their neighbours, but no doubt more details will soon be available when greater quantities of the new elements have been isolated.

The authors suggest that the two newly discovered elements should be named Masurium (Ma) and Rhenium (Re) after the district of Eastern Prussia and after the Rhine respectively. Whether these names will meet with such widespread approval as the research itself remains to be seen.

Current Topics and Events.

IN celebration of the 250th anniversary of the foundation of the Royal Observatory, Greenwich, their Majesties the King and Queen will pay a visit to the Observatory on July 23. We understand that they will be received in the Octagon Room, the original Observatory, by members of the Board of Admiralty and of the Board of Visitors of the Royal Observatory, and will then be conducted over the buildings and shown the principal instruments. On the evening of the same day a conversazione is being given by the president and council of the Royal Society to meet the delegates to the International Astronomical Union. On the following day an official luncheon is being given, presided over by the First Lord of the Admiralty.

AFTER nearly two years' effort, the Australian National Research Council has succeeded in its project for establishing a Commonwealth School of Anthropology, to be attached to the University of Sydney. In December 1923 the Commonwealth Government expressed approval of a scheme submitted to it; in the following year, however, an officer selected by the British Government to advise Australia in the matter of administration of Territories, reported very strongly against the proposal to use such a school for the training of officials. In consequence, Government interest flagged. Renewed efforts, supported by the Australasian Association for the Advancement of Science and the universities, were made in September, and, largely as the result of a visit from Prof. Elliot Smith, who brought unofficial word of warm American sympathy, the Prime Minister promised to provide 1000*l.* per annum towards the expenses of a chair. The estimated yearly requirement being 2500*l.*, the respective States were then asked to contribute the balance of 1500*l.* between them on a population basis. New South Wales, Victoria, Queensland and Tasmania agreed to provide their shares, and South Australia is practically certain to fall into line; Western Australia remains uncertain. The Research Council, therefore, has now asked the Senate of the University of Sydney to consider the immediate appointment of a professor

and the general arrangements for the new school. In doing so, it has laid emphasis on the following points: (*a*) The main work of the chair both in teaching and research should be in the field of social anthropology rather than on the physical or anatomical side, though provision should be made for this also. (*b*) In view of the training of students for Government service in Papua and the Mandated Territories, and for specialised work in the Pacific, the professor chosen should have had actual field experience. (*c*) Though the routine work of the new chair will be under the control of the University of Sydney, it is urged that a permanent Advisory Committee, containing representatives of the Commonwealth, States and Research Council, should be appointed, to assist in the organisation of field research.

AN international conference is shortly to be held at The Hague on the subject of industrial property, that is to say, on patents, trade marks, and designs. It is a matter of considerable importance that Great Britain should be represented by delegates who have had wide experience in patent practice, but if the conference held in 1922 on the proposed Empire patent is to be taken as a precedent, it may be gravely doubted whether any such precaution will be taken. It will be remembered that at that conference the Comptroller was accompanied only by representatives of the clerical staff of the Patent Office, to the exclusion of representatives of the scientific staff who would have possessed both legal and technical training and experience. It is not surprising, in these circumstances, that the conference failed to produce any result, for the very delicate technical question arose of an Empire "search," or examination of all relevant British Empire patent specifications, before granting a patent, and none of the British representatives had that direct acquaintance with the "search" which might have enabled them to deal with this thorny problem in such a way as to satisfy the *amour propre* of the Dominion Governments. It would be far more serious, however, if Great Britain were to be unsuitably represented at an international conference, particularly if the Comptroller should be unable to attend in person. The effect of a given change in international patent practice cannot be instantly grasped by any one who lacks extensive experience of patents, and the interests of British manufacturers may inadvertently be prejudiced by negotiators who are not adequately qualified for their work. We trust that, on the occasion of the impending international conference, full use will be made of the technical knowledge and experience of the Patent Office staff.

THE Santa Barbara earthquakes at the end of last month prove to have been of less importance than the early accounts suggested. By the first, on June 29 at about 6.30 A.M. (2.30 P.M., G.M.T.), many buildings in Santa Barbara were destroyed or damaged (the loss being estimated at from three to six million pounds), twelve persons were killed, and water-mains were broken. The second, on June 30 at 1.22 A.M., is said to have equalled its predecessor in strengt while one of the after-shocks, on June 30 at 4.42 A. is described as severe. The area affected by t earthquakes was apparently small, and this seems indicate that the depth of the foci was comparativ slight. In the neighbourhood of Santa Barb there are several faults running east and west parallel to the trend of the coast-line, and traversi longitudinally the Santa Inez and San Gabr mountains. In the fault-map of California, issued the Seismological Society of America, they are sho as inactive, but it would seem that they are rather a state of moderate activity at long intervals. one or more of these faults Dr. Bailey Willis attribu the group of strong earthquakes on November 27- 1852, and a local earthquake on July 30, 1902 (B Seis. Soc. America, vol. 14, 1924, pp. 18-19). Betw these shocks, on January 9, 1857, an earthqua stronger than any of those mentioned above, was f generally throughout southern California and sever in the Santa Barbara district. Dr. Willis assigns origin to a movement along the extensive San Andr fault, that with which the San Francisco earthqu of 1906 was connected.

A PRELIMINARY report on the Canadian earthqu of February 28 (NATURE, March 7, vol. 115, p. 3 has been issued by the seismologist of the Domin Observatory (*Science*, vol. 61, 1925, p. 584). T epicentre of the earthquake is supposed to be in mountainous region near the eastern boundary of Laurentide Park. Its exact position is, however, present unknown, the region being inaccessible wi the first investigation of the central area was ma Many of the reports of the damage proved to exaggerated or erroneous, but the amount was c siderable at Quebec, Shawinigan Falls, Malbaie, Urbain, and the district near the Rivière Quelle. every case of serious damage the ground was sand clay, usually on the side of a hill, and the buildi were massive stone structures, without steel re forcement, such as churches. A new seismogr station (the sixth in the Dominion) has been est lished by the Department of the Interior at Ste. A de la Pocatière, near the centre of the area affected the earthquake of February 28.

JUNE established a record for its dryness, almost a record for its duration of bright sunsh in England. At the Royal Observatory, Greenwi according to the weather records published by Registrar-General in the Weekly Return of Bir and Deaths, rain fell only on two days, the measu ments being 0·11 in. on June 24, and 0·01 in. June 26, making a total of 0·12 in. for the mon The previous minimum rainfall at Greenwich in J since 1815, in 110 years, was in 1895 and was 0·21 The normal for 100 years to 1915 is 1·99 in., the nor for 35 years, 1881 to 1915, is 2·02 in., and the nor days with rain, 11. The smallest rainfall in a month of the year was in February 1821 and 0·04 in., and in comparatively recent years, si 1900, the smallest monthly total was in April 1 (0·07 in.), and in February 1921 (0·12 in.). Th

was a drought from June 1 until 23. According to the weather correspondent of the *Times* (July 1), June 1925 was the driest June at Kew since records started in 1871, and also the sunniest. The total rain at Kew was 0·04 in. Ross-on-Wye, Calshot (near Southampton), and Falmouth are reported to have had no rain. The duration of bright sunshine at Greenwich was 251 hours, which averages 8·36 hours per day. In June 1914 the sun shone for 267 hours, which is 16 hours more than in June this year. The average duration in June for the 35 years 1881 to 1915 is 201 hours, 6·70 hours per day. The mean maximum shade temperature at Greenwich was 73°·1 F., which is 3°·1 above the normal, and the mean minimum was 49°·7 F., which is in precise agreement with the normal; the excess of heat was clearly due to the intense sunshine in the early part of the month.

WE learn from *Science* that Dr. E. L. Thorndike, professor of educational psychology in Teachers College, Columbia University, has been awarded the Butler gold medal, given every five years by Columbia University for the most distinguished contribution to philosophy or to educational theory, practice or administration, for his contribution to the general problem of the measurement of human faculty and to the application of such measures to education.

THE third annual corporate meeting of the Institution of Chemical Engineering is to be held in the Philosophical Hall, Leeds, on July 17. Afterwards a joint meeting will be held with the American Institute of Chemical Engineers, at which addresses will be delivered by the presidents of the two bodies, Sir Arthur Duckham and Dr. Charles L. Reese, and a symposium on "Industrial Water Supply and Stream Pollution" will be presented. Visits to Messrs. Nobel Industries, Ltd., Messrs. Jos. Crosfield and Sons, Ltd., and the United Alkali Co., Ltd., and to various places of interest in Scotland and England, have been arranged to follow the meeting.

MR. T. R. FERENS, of Hull, is well known for his generous gifts for educational purposes, culminating in a gift of 250,000*l.* for a university college at Hull, referred to in our issue of February 14, p. 239. He has now presented a sum of 20,000*l.* to the Medical School of the Middlesex Hospital for the foundation of an Institute of Otology. The new institute, which will occupy for the present a part of the top floor of premises in Cleveland Street, to which patients from the Middlesex Hospital are being removed during rebuilding of the Hospital, will be devoted to research on the structure, functions, and diseases of the ear, nose, and throat, and it is intended to establish a laboratory, museum, and library.

PROF. R. RUGGLES GATES, professor of botany, University of London (King's College), is sailing from Liverpool on July 14, by the S.S. *Hildebrand*, on an expedition to the Amazon region. He will leave the ship at Manaos and spend a month collecting plant materials in that region and farther down the river. Returning from Para, he will reach England early in October. Prof. Gates is taking Wardian cases to bring back living plants, and will also collect cytological and morphological material for research, as well as some dried specimens. He is also taking a photographic outfit, including a cinema camera and 3000 feet of film, and he expects to make some collections of plankton during the voyage and on the river.

THE control of the administration and the management of the Imperial Institute, South Kensington, has now been transferred, in accordance with the provisions of the Imperial Institute Act, 1925, from the Secretary of State for the Colonies to the Parliamentary Secretary, Department of Overseas Trade. The Imperial Mineral Resources Bureau was amalgamated with the Imperial Institute at the same time, and all correspondence relating to the work of the Bureau should be addressed to the Imperial Institute (Mineral Resources Department), South Kensington, London, S.W.7.

AT the time of going to press (July 8), a reception is being held in the Pavilion of His Majesty's Government at the British Empire Exhibition, and invitations have been issued to view the Science Exhibition arranged by a committee of the Royal Society. The guests are being received by the president of the Royal Society, Sir Charles Sherrington, and the chairman of the Committee organising the exhibits, Mr. F. E. Smith. The Exhibition this year is a decided advance on that of last year, as will be seen from the account indicating some of its main features which appears elsewhere in this issue (p. 50). The Committee responsible for it is to be congratulated on the very representative collection of demonstrations and exhibits brought together. In connexion with the Science Exhibition, a volume entitled "Phases of Modern Science" has been prepared; this includes articles by leading authorities on various aspects of modern scientific research, and a descriptive catalogue of the exhibits. It constitutes a most valuable statement of the present position of physical and biological science. The section describing the exhibits is also being issued separately and is obtainable in the Government Pavilion at Wembley.

THE ninety-third annual meeting of the British Medical Association will be held at Bath on July 21-24, under the presidency of Dr. F. G. Thomson, physician at the Royal United Hospital, Bath. The annual representative meeting of the Association will be on July 17-20. The president will deliver his address and also open the annual exhibition of surgical appliances, foods, drugs, and books on July 21. Sir William Bragg is to deliver a popular lecture during the evening of July 24. The provisional sectional programmes include discussions on the following subjects, the opener's name appearing in brackets after the subject: Endocrine therapy (Dr. W. Langdon Brown and Prof. Swale Vincent), filter-passing viruses (Dr. W. E. Gye), pathological basis of treatment by radiation (Prof. S. Russ), pathology and bacteriology in Great Britain, with special reference to research (Prof. J. C. G. Ledingham), therapeutic value of light

(Prof. W. E. Dixon), food manipulation and health (Dr. W. G. Savage), influence of sunlight and artificial light on health (Prof. L. Hill), and the purity standard of milk (Dr. R. Stenhouse Williams, Dr. W. G. Savage, Dr. E. Pritchard, Mr. W. Buckley, Mr. G. P. Male and Mr. J. H. Maggs, each discussing a different aspect). The honorary local general secretary for the meeting is Mr. W. G. Mumford (British Medical Association Committee Rooms, Assembly Rooms, Bath); and the honorary assistant secretary is Dr. R. G. Gordon.

DR. ALÉS HRDLIČKA, of Washington, is now travelling through India on the first stage of a survey of the field of early man and his predecessors in southern Asia, Australia, and Africa, on behalf of the Smithsonian Institution and the Buffalo Society of Natural Science. In the course of a letter to the former body, he has some interesting observations to make on what he had seen up to the time of writing. Of the physical character of the people he says that the main elements are unquestionably Mediterranean and Semitic, but there are also indications of a Hamitic mixture. He had intended to visit Karachi to investigate the curly-haired people there, but considered this unnecessary, as he was informed that they were known to be of African importation, and that if there were any such natives they must be somewhere at the head of the Persian Gulf, a region now impracticable to reach. At Simla he saw people from the Tibetan borders and some few even from Tibet. Among the latter was one woman who looked a typical American Indian; her dress also strongly suggested the Indian.

THE hundredth annual report of the Bath Royal Literary and Scientific Institution records an earnest effort on the part of the members to revive its interest and usefulness. The ceiling paintings by Andrea Casali have been cleaned, the valuable collection of birds put into good order and the various rooms redecorated. The famous geological collection, containing 27 teeth of *Microlestes moorei* and 70,000 fish teeth from fissures of Rhætic age in the Carboniferous Limestone, is being re-arranged and relabelled as a memorial of the labours of Charles Moore, who did so much for the Museum and for geology. The winter series of lectures interrupted by the War were recommenced in 1921-2, and have steadily increased in number and interest until the accommodation is insufficient. A project for widening the adjoining roadway may result in the present building being taken down, in which case it is to be hoped that the Society may find itself provided with sufficient funds and vigour for the provision of a more suitable and better-placed museum in which the collections can be better displayed.

THE May issue of the *Scientific American* inaugurates a discussion as to whether street accidents due to careless driving would be diminished by the substitution of a regulation as to the distance in which a vehicle should be able to stop for the present speed limit. Mr. H. W. Slauson, who opens the discussion, is of opinion that they would, and points out that the object of the speed limit is to ensure that the driver shall have his vehicle under such co that he can stop quickly when called upon to d He may be under the speed limit, but his phy and mental condition and the state of his brakes be such that he cannot stop quickly enough to an accident: under the speed limit regulation blameless. The fault lies with the regul authority. Under a stopping-distance regula the duty of adjusting the speed to the conditi the driver and his vehicle would rest on the d Roads would be specified as "twenty feet," " feet," etc., and the tests of vehicles would be sir than the present speed tests.

THE Report of the Castle Museum, Norwich 1924, records a large number of gifts, and among a fine series of mounted heads and horns of big bequeathed by the late Mr. E. N. Buxton. accommodate these, as well as the many previous the Museum, it is proposed to extend the bui over a portion of the inner garden. It has also pr necessary to extend the Skin-Room over a va space enclosed by the outer wall of the Castle large collection of flint implements from various sites, presented by Mr. H. H. Halls, has been d upon, with others, to provide a case illustr neolithic culture in Norfolk and Suffolk. In other directions, not so directly within our s this Report bears witness to a progress and act of which Norwich should be proud.

SOCIETIES and Institutions in Great Britain, ing to get into touch with similar bodies in Russ the purpose of exchange or purchase of scientific publications, should address correspon on the subject to one of the following organisatio the hands of which the government of the U.S has placed the responsibility for all arrangemer the kind. For all societies and institutions in L grad: The Publications Exchange Department Academy of Sciences, Leningrad. For all th the whole of the rest of Russia, and for those in constituent territories of the Union of So Soviet Republics: The Book Exchange Bureau U.S.S.R. Society for Cultural Relations with F Countries, Sverdlov Place, Moscow.

DR. C. A. CROMMELIN has published the inau lecture delivered by him on May 12 on the occas his taking up the post of lecturer in physics a University of Leyden (Leyden: Edward Ijdo) is well known, Dr. Crommelin has collaborated Prof. Kamerlingh Onnes for many years in th duct of the experimental researches carried out famous Physics Laboratory of Leyden. In al relates to the science and art of measuring pres temperatures and volumes, he is one of the experienced physicists in Europe, and now that Kamerlingh Onnes has retired, there is perha one in the world who possesses the same know of the intricate technique required in the me ments at low temperatures and high pressures characterises so much of the work done at Le In his address Dr. Crommelin has given a interesting historical sketch of the development

making and using of instruments and apparatus in connexion with experimental research in physics. It is illustrated with portraits of three members of the celebrated van Musschenbroek family and is fully documented with literature references. For many years the laboratory of Kamerlingh Onnes has been a famous training school for young instrument makers and glass-blowers. Perhaps nowhere else in the world has so much attention been given to the development of this side of the work which is required in a great laboratory of experimental research in physics. It is therefore particularly appropriate that Dr. Crommelin should deal with this subject in his inaugural address, which can be heartily recommended to all who take an interest in the history of physical experimentation.

IN the Report of the Rhodesia Museum, Bulawayo, for 1924, the curator, Dr. G. Arnold, records the finding of several palæoliths from an ancient land surface now covered by 15-20 feet of flood-silt from the Umgusa River. He believes "that these implements, mostly of a Chellean and Acheulian facies, were fashioned by the predecessors and contemporaries of Broken Hill Man."

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A part-time research demonstrator in mathematics at University College, Swansea—The Registrar, University College, Singleton Park, Swansea (July 15). Museum assistant and demonstrator in zoology at Birkbeck College—The Secretary, Birkbeck College, Fetter Lane, E.C.4 (July 21). Professor of electrotechnics in University of the Witwatersrand, Johannesburg—Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (July 31). Five appointments in the School of Dental Surgery, Cairo, namely, superintendent and lecturer in metallurgy and materia medica, lecturer in surgery and pathology, assistant lecturer in surgery and pathology, lecturer in mechanics and orthodontia, and a mechanic—The Under-Secretary of State, Ministry of Education, Cairo (August 14). Professor of organic chemistry and director of the chemistry department, Armstrong College, Newcastle-upon-Tyne—The Registrar (August 15). Director of the Rubber Research Institute in the Malay States—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, Westminster, S.W.1 (August 31). A reader in biology in the University of Hongkong—The Chief Medical Officer, Ministry of Health, Whitehall, S.W.1 (September 1). Professor of public health in the University of Edinburgh—The Secretary (September 15). Laboratory assistant for the Mobile Unit, Government Laboratory, Gold Coast—Crown Agents for the Colonies, 4 Millbank, Westminster, S.W.1.

Our Astronomical Column.

DISCOVERY OF A TENTH MAGNITUDE OBJECT.—A telegram from the International Astronomical Union Bureau, Copenhagen, announces the discovery of an object of the tenth magnitude. Its position on June 28 at 1^h $37{\cdot}0^m$ G.M.T. (new) was R.A. 0^h 23^m 28^s, N. Decl. 0° 41′. Daily motion $+1^m$ 48^s, N. 14′. The motion is rather large for a minor planet, unless it should be of the Eros type.

M. Delporte apparently took the plate in the search for Tempel-Swift's periodic comet, using the ephemeris in the British Astronomical Association Handbook. However, as a later examination makes the probable date of perihelion March 1926 (see B.A.A. Journ., vol. 35, p. 159), the object is not likely to be identical with that comet. No further observations are to hand at the time of writing.

THE ROYAL OBSERVATORY, GREENWICH.—Dr. J. L. E. Dreyer contributes an article to the *Nineteenth Century* for July, which summarises the work done at Greenwich during the 250 years of its existence, and emphasises the vagueness of the knowledge of the heavens that existed at the time of its foundation. Tycho Brahe's star catalogue was then the best available, and the best lunar tables differed a quarter of a degree or more from the heavens. Flamsteed's observations of the moon were of great assistance to Newton for comparison with his gravitational theory. Dr. Dreyer vindicates Flamsteed against the charge of withholding these observations from Newton.

The splendid work of Bradley is given due prominence, credit being also given to Bessel and Auwers, who brought the results into a form that later astronomers could utilise. The development of the work of the Observatory under Airy and the further extensions made since his time are also described.

Dr. Dreyer is well known as an astronomical historian, and he has a congenial subject in dealing with the remarkable advance in knowledge since 1675, in which Greenwich has played a considerable part.

THE PHYSICAL STATE OF THE STARS.—While insisting on the incompleteness of the available observational material, Dr. A. Brill, in the *Zeitschrift für Physik* of March 21, attempts to deduce, on the basis of the Eddington theory, general regularities in the connexion between spectral type, surface temperature as deduced from colour and from energy distribution in the spectrum, absolute brightness, mass and other physical magnitudes for a very large number of dwarf and giant stars. It was found that the logarithm of K, Eddington's constant, which determines the mass absorption coefficient k in the interior of a star, only varies from 27·41 to 27·69 between the different spectral classes. $k\sqrt{\epsilon}$ is nearly constant for all stars, where ϵ is the energy radiated in unit time per gram. The following table, abridged from that in the original paper, gives some of the results obtained. Super giants are not considered.

DWARFS.

Spectral Class.	Temp. °C	M(vis).	R. cm.	Mass. gm.	g cm./sec.^{2}	ρ gm./cm.^{3}
O	$28{\cdot}7\times10^3$	− 4·00	711×10^9	738×10^{32}	$9{\cdot}70\times10^3$	$4{\cdot}9\times10^{-3}$
B_0	21·4 ,,	− 1·30	241 ,,	154 ,,	17·7 ,,	$2{\cdot}6\times10^{-1}$
A_0	11·8 ,,	+ 0·90	170 ,,	54·7 ,,	12·6 ,,	$2{\cdot}7\times10^{-1}$
F_0	7·76 ,,	+ 2·65	143 ,,	32·2 ,,	10·5 ,,	$2{\cdot}7\times10^{-1}$
G_0	6·32 ,,	+ 4·50	90·8 ,,	21·3 ,,	17·2 ,,	$6{\cdot}8\times10^{-1}$
K_0	5·23 ,,	+ 6·35	59·7 ,,	15·1 ,,	28·1 ,,	1·7
M_0	3·79 ,,	+11·00	19·2 ,,	6·89 ,,	124 ,,	23
GIANTS						
G_5	4·98 ,,	+0·25	1150 ,,	79·1 ,,	0·399 ,,	$1{\cdot}2\times10^{-3}$
K_0	4·57 ,,	+1·55	824 ,,	56·0 ,,	0·548 ,,	$2{\cdot}4\times10^{-3}$
K_5	3·62 ,,	+0·75	2550 ,,	99·5 ,,	0·102 ,,	$1{\cdot}4\times10^{-4}$
M_0	3·52 ,,	+0·25	3150 ,,	112 ,,	0·0757 ,,	$8{\cdot}7\times10^{-5}$

M(vis) is the visual absolute brightness in magnitudes, R the radius, g the gravitational acceleration at the surface, and ρ the density.

Research Items.

THE ETHNOLOGY OF THE FINNO-UGRIANS.—Dr. U. T. Sirelius has published through the Government Printing Office, Helsingfors, a study of the history, culture, linguistic and physical characters of the Finno-Ugrian peoples under the title "The Genealogy of the Finns." Although it is clear from the concluding chapter, which advocates political independence for those members of the group who have not already attained it, that the pamphlet is a piece of political propaganda, it is nevertheless a useful review of the evidence bearing upon Finno-Ugrian affinities and early history. No comprehensive survey of the physical characters of the Finno-Ugrians has been made, but such available data as are comparable indicate considerable divergence and show that they are no longer even approximately a homogeneous race. They fall into two main groups, one short, comprising Lapps, Ostyaks, and Voguls, all living near the Polar Circle, and a tall group to which belong all the other peoples, Hungarians, Baltic Finns, Volga Finns, and Permians. The Samoyeds, whose linguistic kinship to the Finns is now clear, resemble the members of the former group. In culture also there is a division between the Lapps, the Seryenians of Archangel, the Voguls and Ostyaks, belonging to the north, who live by hunting, fishing, or reindeer breeding, and the remainder, who are tillers of the soil.

PERFORMANCE TESTS OF INTELLIGENCE.—Report No. 31 of the Industrial Fatigue Research Board, prepared by Miss Frances Gaw, describes performance tests of intelligence. Most of the well-known intelligence tests have a decided bias towards linguistic ability, and although for many activities of life language is a necessary medium, yet in dealing with some types, *e.g.* the deaf, the blind, it is necessary to find some other way of measuring intelligence. In the United States, owing to the large population of non-English-speaking foreigners, the study of performance tests has aroused much more interest than in England. This report discusses the need for them, their historical development, the principal scales and uses, and describes a series of performance tests. A comparison of these tests with other estimates of intelligence and with tests of mechanical and constructive ability is given, and there is a useful bibliography. All those interested in intelligence testing will find these tests a useful supplement to the usual ones, and particularly valuable in the case of those children who tend to express themselves in other than linguistic modes.

JAPANESE ALGÆ AND FUNGI.—Dr. Hans Molisch, professor of plant physiology in the University of Vienna, has been travelling for a considerable time in Japan, and Volume 1, No. 2, of the Science Reports of the Tôhoku Imperial University (Fourth Series), Biology, is composed entirely of various notes contributed by him upon his observations whilst in Japan. Dr. Molisch finds the same organism, *Bacterium phosphoreum* (Cohn), responsible for the development of luminosity in butcher's meat in Japan, if this flesh is kept standing in 3 per cent. sodium chloride solution, but not submerged in the solution. He describes curious fusiform bodies in a Japanese species of Vaucheria, which from their reactions appeared to be protein in nature. He records the occurrence of a parasitic Alga, *Mycoidea parasitica* Cunningham, upon leaves of Camellia, and of an epiphyllous Alga, *Phycopeltis epiphyton* Millardet, upon the leaves of various evergreens in Japan. *Pseudoplasmodium aurantiacum* Molisch is described and figured as the species of a new genus of Acrasieæ. Various fungi are described with the habit of growing in and feeding upon the waxy deposits on the cuticles of many species of grasses, of Acer, and of other trees. Some of these fungi were also grown in culture on beeswax. Prof. Molisch also supplies considerable data upon various organisms responsible for the deposition of hydrated oxides of iron in Japan, a subject on which he has already published a monograph based upon his European studies. He also records Nostoc colonies living apparently in symbiosis with two different liverworts, *Blasia pusilla*, L., and *Cavicularia densa*, St.

EFFECT OF THYROID FEEDING ON FOWL PLUMAGE.—Torrey and Horning (1922) reported that when dried thyroid was given to growing males these assumed hen-feathering. Crew and Huxley (1923), repeating this work, but with different material and methods, failed to obtain confirmatory results. However, it was noticed during the course of this work that the administration of thyroid was followed by a marked increase in the rate of plumage growth and replacement, and that in the birds used, Rhode Island Red (red ground with black areas) and Light Sussex (white ground with black areas), the birds receiving thyroid exhibited a pronounced tendency towards increased melanism, the black areas being markedly increased in size and intensity at the expense of the other colours. Since it is known that such a parti-coloured bird tends to become lighter as it ages, the suggestion presents itself that in senility the thyroid of the fowl becomes relatively less efficient in its functioning. Moreover, the observation that thyroid administration increased the rate of feathering in the growing chick and moulting adult gained in significance when Serebrowsky (1922), and more recently Warren (1925), showed that quick feathering as contrasted with slow is a typical sex-linked character. One who seeks to interpret genetic action in terms physiological is attracted by the notion that this sex-linked factor in its action determines the time during development when first the thyroid comes into action or the degree of the functioning of this gland. Cole and Reis (*Journ. Agric. Res.*, 29, 6, 285-287, 1924) also have recently repeated the work of Torrey and Horning and have obtained results which show beyond all doubt that thyroid administration does indeed affect the plumage characters of the male. They found that new feathers grown by the birds receiving desiccated thyroid showed distinct modification towards the female type of structure and colour and that the rate of growth of these new feathers was noticeably increased. There was a reduction of red pigment, the distribution of which was irregular, and also a reduction of that area of the feather in which the barbs lack barbules, the feathers of the hackle regions instead of being pointed and elongate, coming to possess broad rounded ends closely resembling the feathers of these regions in the female.

THE GEOGRAPHICAL RANGE OF THE JURASSIC CRINOID PENTACRINUS.—The imperfection of the geological record is a conception that should constantly be applied to the distribution of extinct creatures no less than to their range in time. Many genera of crinoids, long known from only one country or one quarter of the globe, have of late been found to have a far wider, sometimes indeed a world-wide, distribution. Uintacrinus, Marsupites, and Saccocoma have yielded instances. These, it happens, are

unstalked forms and if, as some suppose, they were members of the plankton, then their wide distribution is readily explained. The latest case, however, is that of a very much-stalked form. The species *Pentacrinus subangularis*, recorded from the Middle and Upper Lias of Europe, has now been found in Alaska. Dr. Frank Springer (Proc. U.S. National Museum, 67, Art. 5) also regards as very close relations some columnals previously known from Dakota and Utah and some lately described by himself from Roti in the Dutch East Indies. This range, he says, far exceeds that of any crinoid of the present ocean. "The deep and clear seas prevailing in the Jurassic and Cretaceous periods were," he thinks, "favourable to the development and spread of marine faunas over large areas with a minimum of checks and interference, in contrast to those of subsequent periods down to the present, in which owing to the great changes in land form affecting the conditions of marine life, and to increasing competition arising from the multiplication of forms, the tendency has been toward progressively greater restriction of faunal areas." This may be, but in this connexion one may recall the many specimens of *Pentacrinus fossilis* attached to logs of wood, and may surmise that *P. subangularis* also belonged to the pseudo-plankton in its young stages. In spite of its wide distribution and its great abundance of individuals, the genus Pentacrinus did not, so far as we know, survive into Cretaceous times.

THE RANGE OF OTHER FOSSIL CRINOIDS.—Another instance of a wider distribution than had been supposed is afforded by the genus Apiocrinus. This crinoid, of which the Bradford or pear encrinite is the best-known example, is not uncommon in the Jurassic rocks of Europe, but has not hitherto been recorded from America. In the Proceedings of the United States National Museum (vol. 67, Art. 18, 1925) Dr. Frank Springer now describes some columnals from rocks, probably of Upper Jurassic age, on the isthmus of Tehuantepec, Mexico, and refers them to this genus as a new species, *A. tehuantepec*. It is also a genus long known only from Europe; at least it was not generally recognised that the Cainozoic form of it was represented in New Zealand. Recently, species of this form have been identified from various other regions of the Western Hemisphere, so that it rivals Pentacrinus in its distribution although so much later in time. This does not quite substantiate the contrast drawn by Dr. Springer. It is still unsafe to base conclusions upon our ignorance. For example, the fossil comatulids, of which so many species are known from Europe, appear as yet to be represented in America only by the rather obscure Microcrinus of Emmons; no doubt they also will be found.

SEISMIC WAVES.—The March issue of the *Journal de Physique* contains the results of the observations of the earth and air waves produced by the destruction of melinite on four dates in May 1924 at the camp of La Courtine in the centre of France. The earth waves were observed by MM. C. Maurain, L. Eble and H. Labrouste by the aid of seismographs recording the vertical, horizontal transverse and horizontal longitudinal movements of the ground at three stations between 5·5 and 25 kilometres from the point of explosion. The waves most rapidly propagated affect the vertical and longitudinal instruments only and travel with a mean speed of 5·52 kilometres per second; the slower or long waves affect all three instruments and travel with a mean speed of 2·80 kilometres per second. At the station nearest to the explosion a further slight transverse wave of speed 4 kilometres per second was observed. At Meudon, 340 kilometres from La Courtine, MM. A. Perot and F. Baldet observed the arrival of the air wave by means of a drum closed by a paper diaphragm and a sensitive flame, and found the mean speed of propagation to be 341·7 metres per second at 16° C., the first effect being a decrease of pressure of 0·6 millimetres of mercury followed by an equal increase.

THE NILE AND ITS FLOODS.—In "A Short Account of the Nile and its Basin," Dr. H. E. Hurst has published a paper he read to the International Congress of Geography (Cairo, 1925), which contains a useful summary of the latest data, accompanied by a large scale map, with regard to the Nile floods. The Nile water supply comes from two sources, first the tributaries rising in Abyssinia, and secondly, the water from the Lake Plateau of East Africa. Very little water from the Sudan reaches the Nile, since it is largely evaporated where it falls. During September, when the water is highest in the main Nile, the Blue Nile contributes 72 per cent., the Atbara 15 per cent., and the White Nile 13 per cent. During the low stage of the main Nile the White Nile supplies 80 per cent. of the water. The White Nile is at its maximum discharge in October, its waters having been held back from July to September by the rapid rise of the Blue Nile. The White Nile water comes from two sources, the Sobat and the Bahr el Gebel and Bahr el Zeraf. Very little is known of the details of the regime of the Sobat, but its maximum discharge is in October and November, while the maximum of the Abyssinian tributaries is in September. The Bahr el Ghazal, in spite of its large basin with a good rainfall, contributes very little water to the Nile. Practically all the discharge of the Gebel and Zeraf comes from the Great Lakes and the plateau, but fully half that enters the swamps of the Gebel is lost. The regime of the lakes is not well known.

SURFACE DAY VISIBILITY.—The Meteorological Office, Air Ministry, in Prof. Notes, Vol. 3, No. 40 (H.M. Stationery Office, Price 3*d*.), has issued a discussion on the ground day visibility at Cranwell, Lincolnshire, during the period April 1, 1920–December 31, 1923, by Mr. W. H. Pick. The relationship dealt with is that existing between ground visibility and the surface wind direction, the surface wind velocity, the existing pressure type, and the presence or absence of convection currents. For the Cranwell area it is concluded that bad or poor visibility is most frequent with wind calm or from about south-east, while good or very good visibility is most frequent with winds from north-eastward or southward. Winds with a greater velocity than 15 m./hr. are seldom accompanied by bad or poor day visibility. Days with convection, taken as days with cumulus or cumulo-nimbus cloud, are likely to be accompanied by good or very good visibility. It is regrettable that, when referring to weather types, numerals only are given, being those affixed by Col. Gold in his "Aids to Forecasting," Geophysical Memoirs, Vol. 11, No. 16. The communication in this respect is comparatively valueless unless the reader has the M.O. publication referred to. In a discussion on similar lines, Prof. Notes, Vol. 3, No. 37, noticed in NATURE, December 6, 1924, p. 838, dealing with pressure type in relation to fog frequency at Scilly during summer months, specimens were given of the different types of weather with which the author was concerned; economy in printing has possibly caused the omission.

A WIDE-ANGLE (180°) LENS.—A compound lens that enables one to photograph the entire inner surface of a hemisphere at one exposure is described by Mr. Conrad Beck in an article in the

Journal of Scientific Instruments, vol. 2, No. 4, 1925. The principle of the method occurred to Mr. W. N. Bond and to Mr. Robin Hill independently, and is that of the view which is obtained of the sky from under water, the "fish's view." Mr. Hill has devised the apparatus, which consists of a large front lens of 2¼ inches diameter, with a curved convex outer surface. At this surface a view angle of 180° is contracted to a cone of about 90°. The inside surface of this lens is very deeply concave, and of such a curve that the central ray from each point of the view passes through it with scarcely any deviation. Close to the apex of the light-cone thus formed is a comparatively small photographic lens. The combination gives an image of the complete hemisphere on a flat disc about 2½ inches diameter, and with an aperture of f/22 good definition is obtained over the whole area. The character of the distortion of the image is described, and an undistorted image of any part of the photograph is obtained by reversing the action of the apparatus so that the lens is used to produce the projected image. The description is illustrated by 5 photographs of the sky, one of the nave of Ely Cathedral, and enlargements from a part of the last and one of the skies. The enlargement of the Cathedral clearly demonstrates the elimination of the distortion.

X-RAY ANALYSIS OF SOLID NITROUS OXIDE AND CARBON DIOXIDE.—It is noteworthy that the Laboratory of Physics and Physical Chemistry of the Veterinary College at Utrecht, in which van 't Hoff held his first appointment at the time when he enunciated his new theory of "Chemistry in Space," is now producing, under the direction of Prof. N. H. Kolkmeijer, an important series of investigations of space-structure by the modern method of X-ray analysis. It was natural that one of the first cases studied in a laboratory so close to that of Prof. Cohen should have been that of white and grey tin, with the result that grey tin was shown by Kolkmeijer and Bijl in 1918 to have the familiar lattice-structure of the diamond. A more recent paper, reprinted from the Proceedings of the Amsterdam Academy, describes the crystal structure of solid nitrous oxide and carbon dioxide. Each substance has a cubic symmetry, the side of the cube containing four molecules of N_2O being 5·72 Å.U., whilst that which contains four molecules of CO_2 is 5·63 Å.U. The distance between two neighbouring atoms is given as 1·15 Å.U. in N_2O and 1·05 Å.U. for CO_2. Another paper records the fact that black precipitated mercuric sulphide, although often described as "amorphous," crystallises in the cubic system and has a structure similar to that of the cubic form of zinc sulphide.

THE SPECTRA OF ISOTOPES.—In the issue of the *Physikalische Zeitschrift* for May 25, Dr. G. Joos, of Jena, summarises the present state of our knowledge of the influence of isotopes on spectra. Up to now trustworthy evidence of such influence has only been furnished in the case of band spectra, in which both the oscillations and rotations of the nucleus are slowed down for the heavier isotopes, as, for example, in the well-known case of the hydrogen chloride doublets. In other cases the observed change of frequency has been used to determine the constitution of the nucleus the movements of which produce the spectral line, and the hydride of the metal concerned has frequently been found to be the effective material. So far, the influence of isotopes on line spectra has only been found in the case of lead, and it appears to be due to some difference of the structure of the nucleus. No direct connexion between the satellites of spectral lines and the isotopes of the material appears to exist.

THE CONTINUOUS SPECTRA OF THE HALOGENS.—After considering the different conditions under which the continuous spectra of iodine vapour and of bromine and chlorine are observed, Dr. W. Steubing has come to the conclusion that they are not of molecular but of atomic origin, though they are not connected with the normal atomic line spectra of the elements (*Zeitschrift für Physik*, May 5). For the production of line spectra, accurately defined orbits with definite energy values are necessary; monochromatic emission will not occur when electron jumps take place which cannot be ascribed to a definite quantum orbit, but the emission will be governed by the laws of chance. It has been shown by the author that the outer electron layer, in the case of the halogens, is very unstable when acted on by magnetic and electric fields, and it is considered probable that it is also unstable for mechanical shocks; a single electron of a broken-up layer will, at first, have no uniquely defined energy, and will only attain this when the layer is completed. Thus the emission will not be monochromatic, but it will lie between certain limits having a definite boundary on the long wave-length side, as is actually observed in these three spectra. Other gases and vapours which emit a continuous spectrum do not exhibit a definite boundary towards the red.

HYDROGEN-NITROGEN AND LIQUID AMMONIA EQUILIBRIUM.—The volume percentages of ammonia in a compressed hydrogen-nitrogen mixture over liquid ammonia have been measured by A. T. Larson and C. A. Black, who record their results in the April issue of the Journal of the American Chemical Society. A true equilibrium appears to exist. The temperature interval used was −22·5° to 18° and the pressure range 50 to 1000 atm. The volume percentages increase with increasing temperature and decreasing pressure; the values are much higher than those calculated from the vapour pressure of liquid ammonia.

QUENCHED CARBON STEELS.—A valuable little paper on "The Structure of Quenched Carbon Steels" was presented at the recent meeting of the Iron and Steel Institute by B. D. Enlund, of Sweden. He has carried out measurements in order to determine the influence of annealing on the electrical resistivity and the specific volume of quenched carbon steels. All the curves show two bends, one appearing at a temperature of 110-120° C. and the other at about 250-260° C., according as the carbon content of the steel is high or low. These bends are visible in all the curves, thus indicating that the same reactions occur in all the steels. The bends consist in all cases of deviations towards the temperature axis, which indicates that a precipitation of cementite takes place at the temperatures mentioned. As is well known, a reaction of this kind is always accompanied by an increase in electrical conductivity. From a knowledge of the phenomena occurring in high-carbon steels quenched from a high temperature, it may thus be concluded that the break in the curves at about 110° is caused by the transformation of martensite into troostite, and the second by the resolution of austenite into α iron and cementite. Though very slight, the second bend in the curves of the mild steels is quite distinct, and it is thus evident that even such steels contain γ iron representing untransformed austenite. This is a very interesting and valuable conclusion to have established. The formation of troostite at 110° C. is accompanied by a contraction, whereas the precipitation of α iron and cementite at 250° C. causes an expansion.

The National Physical Laboratory, Teddington.

ANNUAL VISITATION.

ON Tuesday, June 23, the annual visitation by the General Board of the National Physical Laboratory took place. In accordance with custom a number of members of scientific and technical societies and institutions, government departments and industrial organisations, were also invited to the Laboratory, which was open for inspection. The visitors were received in the new Aerodynamics Building by Sir Charles Sherrington, president of the Royal Society and chairman of the General Board, Sir Arthur Schuster, and the Director of the Laboratory, Sir Joseph Petavel. Prior to the visitation the new entrance to the Laboratory, in Queen's Road, was formally opened by Sir Charles Sherrington.

Referring to the general development of the Laboratory, Sir Charles remarked that it is now twenty-five years since the Laboratory came into being, and in that period it has come to occupy an all-important place in the national organisation for the advancement of science. This rapid growth is a testimony of the energy and ability of the first Director, Sir Richard Glazebrook. With the further expansion under his successor, Sir Joseph Petavel, arose the demand for new roadways. Their construction was begun in 1922, and the projected development included the improvement of the approaches to existing buildings and the reconstruction of the entrance from Queen's Road. It is gratifying that the new roads have been named Kelvin Avenue and Rayleigh Avenue. The service which the late Lord Rayleigh rendered to this institution cannot be overstated, and forms an abiding part of its high tradition.

An extensive series of exhibits had been arranged to illustrate the general character of the work of the Laboratory.

In one of the seven-foot wind channels in the Aerodynamics Department was a model for investigating the performance of the autogyro, a machine representing an innovation in aeroplane design. This machine differs from the orthodox type in that it has no wings, their place being taken by an airscrew on an axis which is nearly vertical. The machine is equipped with a motor and propeller as usual, and the motion of the air past the vertical screw as the machine gathers speed causes it to rotate and to lift the machine from the ground. It is claimed by the inventor of this machine (which is being developed in Spain) that an almost vertical landing is possible and that it will not stall.

In the four-foot wind channel was exhibited an apparatus for investigating rapid fluctuations of wind velocity, such as occur in the eddy region behind an obstacle placed in the channel. Owing to lag, ordinary anemometers cannot follow these variations, and the possibility of using hot wire anemometers for the purpose is being explored. A hot platinum wire forms one arm of a Wheatstone's bridge, and changes in wind velocity affect its resistance, disturbing the balance of the bridge. The corresponding variations in the current are shown by an Einthoven galvanometer. With the finest platinum wire one-thousandth of an inch in diameter, fluctuations of 2 or 3 per second are faithfully recorded.

In the Engineering Department an interesting exhibit was an instrument for recording the vibrations of structures. In this an arm carrying a small stylus is so pivoted on a frame that it responds to very minute vibrations of the frame. Supported by means of springs is a system possessing large inertia compared with the vibrating portion and carrying a smoked glass plate, on which the vibrations of the stylus are recorded. The stylus magnifies the vibrations twenty times, and a further magnification of fifty times is obtained by optical projection. A testing machine for big-end bearings of petrol engines was also shown. This work has been undertaken in connexion with the development of high-power lightweight internal combustion engines.

Other exhibits included apparatus for investigating the impact strength of chains and for examining the stress set up in pipe sockets due to caulking. In this connexion it has been shown that for some time after caulking there is a definite slow reduction in caulking stress, indicated by a gradual reduction of the outside diameter of the socket.

The Department of Metallurgy and Chemistry displayed specimens of light alloys which had been treated for the removal of occluded gases. One of the defects of aluminium alloy cast in sand is " pinholing " due to the presence of these gases, the degree of occlusion of which is affected by the rate of solidification. If the alloy is cast in a metal mould, solidification is rapid and the gases are retained in solution.

There were also shown examples of the pure metals manganese, chromium, and iron, prepared in the Laboratory. Pure iron and chromium are produced by electrolysis from an aqueous solution of their salts. Pure manganese is prepared by distillation from the commercially pure mineral in a high-frequency induction furnace in vacuum, which is also used in the preparation of pure alloys of these materials. Special refractory crucibles made from pure magnesia and alumina were produced for this purpose. A further exhibit showed beryllium obtained by the electrolysis of fused beryllium salts. The metal has a high degree of purity and is produced by slowly withdrawing the cathode, thus forming a rod which is afterwards melted in the induction furnace already mentioned.

The Chemistry Section displayed apparatus for determining the viscosity of molten glass. The glass is contained in a platinum crucible in an electric furnace, and is withdrawn adhering to a fine platinum wire moving at a definite rate, the temperature of the furnace being observed with an optical pyrometer. The viscosity is obtained from the weight of glass adhering to the wire.

In the William Froude National Tank there was shown the apparatus for the investigation of the movements of a lifeboat on a slip-way during launching. As the boat traverses the slip-way, the progress of its bow and stern are recorded electrically after each fall of 6 inches. The conditions under which the tests are being conducted include varying slip declivity and friction, smooth and stormy water, and different states of the tide. An exhibit of popular interest was a wax model of H.M.S. *Victory*. This was ballasted and towed from the travelling carriage of the tank so as to simulate the course which a sailing ship would take under sail, and its leeway could be measured. The apparatus for determining the resistance and running angle of flying boat hulls in motion prior to taking off was also shown.

In the Metrology Department were a number of exhibits dealing with high precision measurements, and comprising standards and measurements of mass and length, measurements of volume, and the testing of hydrometers, barometers, and chronometers.

Another exhibit was a new form of cadmium lamp

recently invented by M. Hamy which contains no internal electrodes. It is stated that the spectrum from this is identical with that from the Michelson cadmium lamp, which in the past has been used for experiments on the use of a wave-length of light as a fundamental unit of length. The comparison of a 6-in. and a 36-in. Fabry-Perot étalon illustrated how, by stepping up, lengths of the order of a metre and over can be measured accurately in terms of the ultimate unit.

The apparatus for silvering the plates used in interferometry methods of measurement was shown. The glass plate forms the anode of a vacuum vessel, and the cathode, of silver, is hung above it. The silver film is deposited on to the plate by the passage of an electric discharge. Films from 1 to 2 millionths of an inch in thickness can be obtained by this method.

In the workshop was a machine for facilitating the accurate lapping of pivots. In this the work in progress is magnified by projection, and the operator can compare the magnified image with an outline drawing, on the same scale, of the required profile.

The Physics Department was responsible for a large number of exhibits. Among them was an apparatus for the determination of the effect of humidity on the mobility of ions. A heated platinum wire mounted in an insulated metal tube is used for the production of the ions, which are drawn to the outer tube by the application of an electric field, the thermionic current being measured in the usual manner by means of an electrometer. The experiments are conducted at atmospheric pressure, and the humidity of the air surrounding the heated filaments can be adjusted. Another interesting exhibit was an apparatus for the determination of the heat loss from bare pipes. A graphite rod extending from end to end of a long iron pipe is heated electrically and the energy dissipated in it is measured. The corresponding temperatures at various points along the pipe are measured by thermocouples.

In the Sound Section was an apparatus for the photographing of sound waves. The passage of an electric spark across a short gap produces a single spherical sound pulse, the shadow of which is afterwards photographed under the illumination of a second spark. By using this apparatus in conjunction with sectional models of buildings, the acoustic properties of the latter can be determined.

The purity of the sounds produced by electrical apparatus used in acoustical work depends upon the wave-form of the electrical oscillations. A cathode ray oscillograph for the study of the latter was shown, the spot describing a circle on the fluorescent screen when the oscillations are sinusoidal.

Among the exhibits of the Radiology Section were Laue photographs of diamonds used as pivot bearings. In this connexion it has been found that the direction of the cleavage plane of the diamond with reference to the bearing surface is of great importance.

In the Optics Section were shown a flicker photometer for heterochromatic photometry and a spectrophotometric equipment using unpolarised light. In the latter, the absorbing optical parts are reduced to a minimum and measurements are made by a Lummer-Brodhun contrast field. As a result the instrument is very efficient at low illuminations. It possesses two collimators, and the light from the two sources is brought to approximate equality by means of rotating sector discs, the final balance being obtained by means of a wedge in the path of one of the beams.

In the Electrotechnics Department, Alternating Current Division, a recently constructed power-measuring apparatus was on view, including a precision electrostatic wattmeter. Another exhibit consisted of the calibration of a 10,000 kilowatt 3-phase watt-meter operating at 6600 volts. This calibration is carried out by the employment of a fictitious load method in which the pressure and current coils are separately excited. In the Direct Current Division was shown a 5000 volt direct current set, for tests on equipment connected with railway electrification. In particular, it has been used for the testing of impregnated timber designed to protect railway workers from shock through accidental contact with the live rail.

The exhibits of the Photometry Division included the apparatus for the standardisation of electric incandescent lamps in terms of the international candle and for the measurement of mean spherical candle power. In the experimental illumination building, demonstrations of the use of the daylight factor meter—an instrument for the direct measurement of the proportions of the total external daylight reaching various points in a room—were in progress.

In the Wireless Division was an oscillograph used for analysing the wave-form of a valve oscillator and amplifier. A condenser in the grid circuit of an oscillator discharges linearly through a diode, and the discharge can be synchronised with the oscillations to be measured. The actual wave-form is traced out by the spot on the fluorescent screen of a cathode ray oscillograph. Another interesting feature was an apparatus for the measurement of the intensity of the field from a distant radio transmitting station.

A number of piezo-electric quartz resonators and oscillators for the purpose of radio frequency standardisation were shown in the Electrical Measurements and Standards Department. These oscillators form extremely constant sources of radio frequencies and are capable of controlling the output of valve generators. Another exhibit was a standard sonometer for the measurement of audio frequencies. The apparatus is very simple in principle. It consists of a phosphor-bronze wire loaded with a heavy weight. The wire passes between the poles of an electro-magnet and carries the current the frequency of which is under measurement. A sliding bridge with rack and pinion enables the free frequency of the wire to be brought into synchronism with that of the source. A pointer indicates the frequency directly. Various scales corresponding to modes of vibration in one, two, three, five, and ten loops, are used. The total range is from 100 to 10,000 cycles per second, with an accuracy throughout of 1 in 1000.

Glacier Lassitude.

ON the Mount Everest Expedition, 1924, a peculiar condition of prostration and lassitude was experienced by its members whilst crossing ice under certain conditions. The appearance of this fatigue was found to coincide with the presence of a hot sun and a still air: this combination of conditions led to a saturation of the stratum of air on the glacier with moisture, so that the loss of heat from the body was interfered with. The effect was not due to altitude alone, since the lassitude disappeared the moment the observers left the glacier, and was not experienced in the early morning or late evening.

The explanation of this effect given by Major Hingston has been confirmed by some experiments undertaken by Leonard Hill and A. Campbell (*Lancet*, 1925, vol. i. p. 939). The authors examined the

effects of work with the bicycle ergometer in ordinary atmospheric air (21 per cent. oxygen) with a dry bulb temperature of 20° C. and a low cooling power, and with a temperature of about 8° C. and a high cooling power, and compared them with those produced by similar temperatures when the air breathed contained only 11-13 per cent. of oxygen: this level of oxygen was sufficiently low to produce symptoms of deficiency of oxygen in the experimental subject, such as weakness, giddiness, and cyanosis. It was found that an atmosphere with a low cooling power, or one with a lowered oxygen content, increased the pulse-rate more than one with a higher cooling power or a normal oxygen content: the effect of cooling power was observed whether the atmosphere contained a low or a normal amount of oxygen, while the effect of variation in the oxygen supply was seen independently of the cooling power of the atmosphere. When the two more disadvantageous conditions were combined in one experiment, that is, a lowered percentage of oxygen in the air breathed together with a low cooling power of this atmosphere, the increase in the pulse-rate was about equal to the increase due to the anoxæmia plus that due to the low cooling power. In the two subjects examined, the increase due to these two factors combined was about 24 and 36 beats per minute respectively: and at the same time the symptoms of anoxæmia and discomfort were more marked under warm conditions with a low oxygen tension. It was also found that there was no hindrance to the passage of oxygen across the pulmonary epithelium when air with a low oxygen tension but saturated with moisture was breathed, so that the results observed appear to be due to the two factors of overheating of the body and of breathing oxygen at low tension. The pulse-rate alone is a guide to the distress of the heart under these conditions.

An obvious means of counteracting the effects of altitude is to increase the oxygen in the air breathed by a supply from some form of apparatus, but in the last expedition this method was found to be of little benefit. Hill and Campbell make the following suggestions to account for this finding. The observers have been in an atmosphere containing a low oxygen tension for a considerable time, and the effects of enriching this atmosphere with oxygen may be different from those observed in unacclimatised subjects submitted to acute anoxæmia for short periods. A further factor is the difficulty of obtaining the full amount of oxygen given by the apparatus, some being almost inevitably wasted, without the wearing of a face-piece. Finally, the authors lay stress on the oxygen dissolved in the plasma in distinction from that in combination with the hæmoglobin in the corpuscles. It is of course the dissolved gas which is immediately available for the tissues, and the amount of this depends on the tension of the gas in the alveoli of the lung. Breathing air containing 30 per cent. oxygen at 29,000 feet would give only about 60 mm. mercury tension of this gas in the alveolar air. Although this would saturate the hæmoglobin to 90 per cent., the amount of gas dissolved in the plasma would be only about two-thirds of that normally present when ordinary atmospheric air is breathed, so that the supply available for the tissues would still be distinctly subnormal.

The Middle Carboniferous of the North of England.

MR. W. S. BISAT'S paper on "The Carboniferous Goniatites of the North of England and their Zones" (Proc. Yorks. Geol. Soc., N.S. vol. 20, 1924, pp. 40-124 and Pl. I.-X.) must take rank as one of the classics of Carboniferous stratigraphy. It provides the first clear guide to the "no man's land" of grits and shales which lie between the Carboniferous Limestone and the coal measures, while it will also be of the greatest value in the correlation of the Coal Measures themselves by providing a sure base from which to work.

The Goniatite succession is traced from the upper Viséan to the base of the Upper Coal Measures (of Lancs. and Yorks.). Zones D3 and P (the latter characterised by *Goniatites s.s.*) are retained in the Viséan. They are represented by the "knoll" limestones and the Bowland shales, which are regarded as in part contemporaneous. For the overlying beds, up to and including part of the Lower Coal Measures, the term Lancastrian is introduced. These beds are divided into the zones of Eumorphoceras (E), Homoceras (H), Reticuloceras (R) and Gastrioceras (G) in ascending order. Hinde's Pendleside group (=Bowland shales) is found to be substantially equivalent to the Yoredales in age, and it is therefore proposed to discard the term, retaining Bowland shales as a facies name. The group belongs partly to P (Viséan) and partly to E (Lancastrian). The Yoredales of Derbyshire belong mainly to a higher horizon (upper E and H), corresponding to the Sabden shales of the Pendle area, while the overlying Kinderscout grit and shale is referred to R, leaving the upper portion of zone R together with zone G for the higher grits and part of the Lower Coal Measures. The major (generic) zones named above are divided into minor (species) zones, of which twenty-one are recognised. Local details of the zonal determinations are given somewhat fully for south Yorkshire and Lancashire, with more brief reference to other areas.

The value of the stratigraphical portion of the paper is dependent on the full study of Goniatite palæontology on which it is based, and which forms the second (and larger) section. This constitutes a monograph on the family and one only regrets that it is not in more definitely monographic form. In its present relations, it is naturally concerned mainly with the diagnostic characters of species and varieties, and has less emphasis on their mutual relations and general evolution, though the section commences with an excellent key to the genera. The ontogenetic history is found to be strikingly uniform throughout the family, especially in regard to sutures, but with the usual independence in the rate of development of the several characters. Fifteen genera (four new) and fifty-six species (thirteen new) are described. The largest number belong to the zones D, P, E, and H, below the Kinderscout grit. Above that horizon only Reticuloceras (in the grits) and Gastrioceras (in the upper grits and Lower Coal Measures) appear to occur. A noteworthy feature is that the sutural development is at its maximum in the earliest zones, the species which follow being evidently katagenetic in this respect. The history of the other characters is less obvious, but the striking reduction in the number of species and the variability of the later forms seem to confirm a general decadence of the family. All those interested in Carboniferous stratigraphy will look forward with the highest interest to the further extension of Mr. Bisat's work.

The same part of the Yorkshire Geological Society's Proceedings contains a valuable résumé by Mr. G. W. Lamplugh of our present knowledge of the Speeton clays (the presidential address) as well as other important contributions.

Societies and Academies.

LONDON.

Optical Society, May 14.—F. W. **Preston**: (1) The fundamental law of annealing. The fundamental law of annealing, that the rate of decrease of stress varies as the square of the stress present, is deduced from first principles by means of dimensional analysis, assuming that the rate of decrease of stress depends, (1) only on the stress present and the viscosity; (2) on the stress present, the viscosity, and the rigidity of the material. The law suggested as an empirical relation by Adams and Williamson is true dimensionally.—(2) The dimensional accuracy of Mr. Hampton's paper on "The Annealing of Glass." No corrections are made in Mr. Hampton's results, which are based on sound reasoning. The practical conclusions of Mr. Hampton's paper are justified in every way.—T. **Smith**: Note on the cosine law. Objections raised to the statement that rays selected by a cosine relation determine caustic surfaces in the object and image spaces, and to some points in the proof of the cosine law, are considered, and the adoption of the original enunciation of the theorem justified as opposed to the modified form suggested by Hertzberger and approved by Boegehold. A direct derivation of the analytical form of the law of refraction from the cosine law is given.

Royal Statistical Society, May 19.—Sir Napier **Shaw**: Week or month as an intermediate time-unit for statistics. In agriculture the week is generally recognised, but the month often exerts a certain dominance; in finance the year is the chief unit and next to that the week; for meteorology the calendar month is dominant and the week is only used at present for special purposes such as correlation with agriculture or hygiene; for railway statistics the calendar month and year again are dominant; for social statistics (Poor Law, etc.), the week is the favourite unit; for trade and shipping the month is used exclusively, whereas the week and corresponding quarters are the bases of vital statistics in the majority of countries; Brazil, Bulgaria, Hungary and Italy, however, use the month for that purpose. Starting from the conclusions: (1) that the original purpose of the month to keep in touch with the phases of the moon has not been successful, (2) that the division of the year into twelve unequal parts is not a fundamental principle of statistical science, (3) that a period shorter than a month is necessary for various reasons of correlation, and (4) that there is no possibility of using monthly data in connexion with weekly data or vice versa; a suggestion is put forward for placing statistical data upon a basis of weeks or groups of weeks with an adjustment to the calendar year. The grouping of the fifty-two weeks of the year into thirteen groups of four weeks each, or four groups of thirteen weeks each, is left open. For general climatic purposes a quarterly arrangement with judicious selection of the quarters might be sufficient.

Geological Society, May 20.—H. **Dewey**: Palæolithic implements of Chellean type found in the gravel of Hyde Park, London. The implements were collected from gravel thrown out of a deep trench of length 44 feet, breadth 14 feet, depth 40 feet. The London clay has been exposed at the northern end of the excavation, but falls suddenly at the southern end to an unknown depth. The gravel therefore covers a step-like fracture, which curves round from west and east to north-east. The stones are principally Chalk-flints. The implements were all from a depth of 26 feet. They include one hand-axe of Chellean type; the topmost portion of a second hand-axe; two choppers worked along the edges so as to provide a comfortable hold; two long flakes or flake-scrapers; a broad flake or grattoir; and some pieces showing a certain amount of human workmanship.—J. W. **Tutcher** and A. E. **Trueman**: The Liassic rocks of the Radstock District (Somerset). These rocks are unusually interesting, because in some divisions they are very thin; the total thickness of Lias does not exceed 200 feet, and is often much less. The succession of rocks has been worked out. An unusual number of ammonite faunas are richly represented, often in remanié deposits. Deposition of White Lias occurred during a time of fairly uniform subsidence, and was followed by folding along east-and-west axes, and denudations of the anticlinal areas. Deposition was renewed and followed by uplift in the south and denudation of much of the clay there. Then came deposition of the Obtusum nodule-bed and of the Raricostatum clay, and afterwards renewed uplift in the south and denudation. Further deposition included the Armatum bed in the south only, a remanié bed; the Jamesoni limestone, fairly uniformly; and the Striatum and Capricornum clays.

EDINBURGH.

Royal Society, May 25.—John **Thomson**: Parasitism of *Cuscuta reflexa* (Roxb.). The hyphæ or modified root-hairs are differentiated into strands of tracheids when they meet the xylem vessels of the host. Those which enter the host phloem are not modified; moreover, the shaft of the haustorium contains no sieve-tubes. The irritation set up by the entry of the haustorium stimulates all the living cells in the neighbourhood of the haustorium to active cell-division. In woody host stems the general result is to increase the radius of the stem of the host on the side invaded by the parasite. Connexion with the host xylem is maintained by the differentiation into tracheids of young parenchyma cells at the tip of the haustorium. Experiments in growing the parasite on peeled stems demonstrate that the plant can live on the materials derived from its host's wood, even when its chlorophyll is prevented from functioning by enclosure in a light-tight box. The haustoria formed in such circumstances are perfectly normal except that their size is less. These facts suggest that a plant's xylem is capable of transporting plastic materials as well as water with mineral salts in solution.—C. W. **Wardlaw**: Size in relation to internal morphology: No. 2, The vascular system of Selaginella. The xylem is in the form of a thin ribbon, an arrangement which makes for a large surface of interchange with living tissue. With increase in size the xylem band widens out. Where the vascular system is of large size, the broad stelar ribbon must be broken up in order to be adequately disposed in the stem. Such species are polystelic with three to five stelar ribbons, and measurements show that a constant ratio exists between the width of the median stele and the diameter of the stem. The polystelic species have been regarded as derivative and specialised types. From the foregoing argument however, it follows that polystely is not necessarily a derivative condition in the phyletic sense, but is a modification in form consequent on increase in size. Hence the isolated position of those species which show polystely in Baker's systematic arrangement need not be held as destructive of the validity of that classification.—S. **Williams**: Some points in the anatomy of Dicksonia. *D. antartica* and *squarrosa*

possess dictyosteles not far removed from solenostely. In both the stele appears in transverse section as a curiously corrugated cylinder due to the oblique passage of the leaf traces through the cortex. Inwardly projecting flanges are present in both species at the margins of the leaf gaps. From a study of the anatomy of the above large stems and of a number of other examples, it is concluded that increase in size of the stele in the vast majority of ferns has been accompanied by (*a*) adaptations to increase the surface of interchange between the stele and the surrounding tissues, and (*b*) modifications of the xylem mass to ensure constant contact between the tracheids and living parenchymatous elements.—A. E. **Trueman** and Miss Daisy **Williams**: Studies in ammonites of the family Echioceratidæ. The paper deals with those ammonites from the Lower Lias which were formerly referred to *Echioceras raricostatum*. In creating several genera and in describing the species, considerable attention has been paid to the evidence obtained from the study of the ammonite sutures and from the shell development. Discussing relationships and descent, it is shown that the development of an ammonite shell frequently tends to follow the most direct line from the embryo to the adult form, and that this ideal ontogeny may be achieved by the skipping of ancestral stages which do not fall on the direct line or which do not fit the embryo for its particular environment.

PARIS.

Academy of Sciences, June 8.—L. **Lecornu**: The phenomenon of refraction. A discussion of the condition which must be fulfilled by a force acting on a material point so that its velocity on change of medium may vary as predicted by the wave theory. Jules **Andrade**: Concerning a theorem of metrology: elastic clocks and spiral balances.— — **Tzitzéica**: Certain skew curves.—M. **Soubbotine**: The law of errors of observation.—Lawrence M. **Graves**: Taylor's theorem in general analysis.—D. **Pompeiu**: The monogeneity of functions of one complex variable.—P. **Noguès**: The invention of the kinematograph. During the period from 1882 to 1890, Marey realised the fundamental arrangement which constitutes what is now called the kinematograph.—L. **Ollat**: The resonance of coupled circuits.—J. **Cayrel**: Detection with galena. With a single isolated sensitive crystal, only the (111) faces have given rise to normal intense detection. The (100) faces, on the contrary, show a very feeble detection, nearly always inverted and often unstable. With insensitive crystals the (111) and (100) faces behave similarly: both show inversion.—E. **Bodin**: The peculiarities presented by radiation cells of great electrical resistance.—G. **Ribaud**: High frequency induction electric furnaces for the production of very high temperatures. A description of the construction of an induction furnace open at two ends and permitting the attainment of a temperature of 2500° C.—G. **Reboul**: A new mode of production of slow cathode rays.—La **Rosa**: The velocity of light and its dependence on the movement of the source of light. Reply to a communication by M. Salet.—Léon and Eugène **Bloch**: The spark spectra of chlorine. An extension of the method of analysis of spark spectra given by the authors in an earlier communication and its application to the analysis of the spark spectra of chlorine.—Pierre **Auger** and Francis **Perrin**: Theoretical considerations on the directions of emission of the photo-electrons.—Pierre **Brun**: The miscibility of mixtures of water, ethyl alcohol, and isobutyl alcohol. The results of the experiments are given in the form of graphs.—Georges **Denigès**: A new method of diagnosis and of immediate determination of cobalt by spectroscopy and chromoscopy. The blue colour given by cobalt compounds with hydrochloric acid has a specific absorption spectrum: the reaction detects 0·02 milligram per cubic centimetre of solution. The method is of service in the detection and estimation of traces of cobalt in commercial nickel and its salts.—Maurice **Nicloux**: The determination of carbon monoxide by the blood method and some remarks on the absorption of this gas by hæmoglobin in the absence of oxygen. Details of the technique of the method, which is shown to be capable of detecting carbon monoxide in the proportion of 3 parts per million.—M. **Bourguel**: The hydrogenation of the triple link. The formation of *cis*-ethylenic compounds. Using colloidal palladium as the catalytic agent, the reduction with hydrogen at the ordinary temperature of various acetylene derivatives has always given the *cis*-ethylene compound. This is in accord with the geometrical representation ordinarily adopted for the double and triple linkages in acetylene and ethylene derivatives.—Max and Michel **Polonovski**: The aminoxides of the alkaloids of the tropane group.—R. **Locquin** and R. **Heilmann**: New trinitrogen bases: the ureas of the pyrazolines.—E. E. **Blaise** and Mlle M. **Montagne**: The acyclic δ-diketones. Transformation into pyridine derivatives. The action of hydroxylamine upon the δ-diketones constitutes a general method for the preparation of pyridine bases.—R. **Bourret**: The geology of the region of Pak Lay (Middle Laos).—L. **Duparc**: Some curious lode-bearing rocks in the neighbourhood of Mestigmer (Morocco).—E. Vander **Linden**: A case of striking by lightning.—Marcel **Mirande**: The phytosterol of the scales of bulbs in the species of the genus Lilium.—C. **Charaux** and P. **Delauney**: The presence of loroglossine in *Listera ovata* and *Epipactis palustris* and on some new reactions of this glucoside.—R. de **Litardière**: The phenomenon of cytomixis in the microsporocytes of *Podophyllum peltatum*.—Ladislas **Smolik**: The exchange of the aluminium ion of soils of different types against the potassium ion of a neutral salt.—Antonin **Nemec**: The hydrogen-ion concentration in the tissue of seeds. The experiments recorded show that the hydrogen ion concentration in the seed tissues indicates, at least approximately, the value for the reaction of the medium favourable to the development of the plants arising from the seeds.—Auguste **Lumière** and Rémi **Courjon**: The influence of the time of coagulation of the blood on the toxicity of sera.—L. M. **Betances**: The genesis of the blood platelets.—H. **Chatellier** and H. P. **Chatellier**: The embryological evolution of the endolymphatic outlet in man.—E. **Aubel** and J. **Salabartan**: The significance of the decomposition products formed by the coli bacillus at the expense of glucose.—P. **Lasareff**: The statistical theory of the adaptation of the eye in the course of peripheral vision.—Ch. **Porcher**: The action of carbonic acid on the calcium caseinates. Introduction to the study of colloidal calcium carbonate.—P. Cappe de **Baillon**: The general characters of double monsters in phasmids.—J. **Beauverie**: Does the bacterial symplasm exist? The case of Azobacter. After an extended period of cultivation of *Azobacter chroococcum*, it has not been found possible to prove the existence of a regenerative symplasm which was not the result of a degenerescence, of a contamination, or of an erroneous interpretation. The author regards the formation of a bacterial symplasm as unproven.—Charles **Kayser** and Mlle Eliane Le **Breton**: The regulating mechanism of purin metabolism: diabetes.— — **Paillot**: The cytological

alterations in the course of the evolution of the disease of the nucleus of the larvæ of *Pieris Brassicæ*.

CAPE TOWN.

Royal Society of South Africa, April 15.—H. Spencer **Jones**: Notes on solar parallax. A good determination of this constant is important for establishing a base-line on which our knowledge of the dimensions of the visible universe is founded. The methods of its determination may be divided into three classes: (1) The observation of the apparent displacements of a planet like Mars or Eros against one or more stars viewed from two points differently situated in relation to the centre of the earth; (2) determinations of the orbital velocity of the earth compared with the velocity of light; (3) observations of occultations of stars by the moon, from which the perturbing influence of the sun on the moon's orbit can be ascertained. The best determinations of the solar parallax from these three independent methods lead to almost identical results, namely, 8″·805 with a probable error +0″·002.—Louis P. **Bosman**: Some observations on aconitine: Aconitine ($C_{34}H_{47}NO_{11}$) on oxidation yields oxonitine $C_{24}H_{31}NO_9$. It is known to contain three (CH_3O) groups, one (CH_3CO) group, one (C_6H_5CO) group, and one N . CH_3 group. There seems to be an inner anhydride of a dicarboxylic acid.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 4, April).—T. Y. **Thomas**: On the projective and equi-projective geometries of paths.—O. **Veblen** and J. M. **Thomas**: Projective normal co-ordinates for the geometry of paths. They are independent of the components of affine connexion appearing in the differential equations of the paths. Equations of paths through the origin are linear.—J. M. **Thomas**: Note on the projective geometry of paths. Projective tensors other than the Weyl curvature tensor can be derived.—W. **Hovgaard**: Determination of the stresses in a beam by means of the principle of least work. No *a priori* assumptions are made as in Saint-Venant's method.—M. T. **Bogert** and C. N. **Andersen**: Researches on selenium organic compounds. V. A simple method for the synthesis of 2-substituted benzoselenazoles.—Alice H. **Armstrong**, W. **Duane**, and R. J. **Havighurst**: The reflection of X-rays by alkali halide crystals. Using a potassium iodide crystal and reflecting X-rays from the 100 planes gave a double image and a series of fine lines, due apparently to minute crystals with their axes parallel to that of the main crystal. This habit of crystal growth is suggested as the cause of the abnormal reflections obtained with the alkali halides.—I. I. **Rabinov**: Note on the diffraction of X-rays by a wedge-shaped slit. A fringe was obtained using the K_α line of molybdenum. Calculated width of slit, 0·0013-0·0018 mm.—D. L. **Webster** and P. A. **Ross**: The Compton effect with hard X-rays.—E. O. **Salant**: The heat capacity of solid aliphatic crystals. Many assumptions are made, but equations are derived from which results fairly in accord with experiment can be computed.—G. P. **Baxter** and H. W. **Starkweather**: The density and atomic weight of helium. Three 1-litre globes were used, as in the determination of the density of oxygen (NATURE, March 28, p. 483). Average density of helium, 0·17845. Using the density found above for oxygen, namely, 1·42901, and assuming that helium obeys Boyle's Law for the range 0-1 atmosphere, the atomic weight of helium, for various values of $(PV)_0/(PV)_1$ of oxygen, varies from 3·9995 to 4·0000.

Diary of Societies.

TUESDAY, JULY 14.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 11 A.M.—Presentation of the society's medal to W. F. Reid.—Presidential Address: Dyestuffs.—In evening.—Prince G. Conti: How the Tuscany Boric Acid is made (Lecture).

CONVENTION OF ENGLISH-SPEAKING OPHTHALMOLOGICAL SOCIETIES (at University College) (also on July 15, 16, 17).

WEDNESDAY, JULY 15.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 9.30 A.M.—Symposium on Coking Practice; Chairman, Prof. J. W. Cobb.—Dr. R. Lessing: The Influence of Ash Constituents on the Coking Process.—R. A. Mott and R. Wigginton: The Heating of Coke Ovens.—C. P. Finn: The Disposal of Coke Oven Gas for Public Supply.—W. H. Hoffert: A Comparison of Different Solid Adsorbents proposed for Benzole Recovery.

INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 11 A.M.—Opening of the Conference by the President, H.R.H. the Duchess of York.—Speakers: Viscountess Rhondda: Commerce.—Miss Ellen Wilkinson: Industrial Organisation.—Prof. Winifred Cullis: Science.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Dr. J. A. Mjoën: The Analysis of the Component Faculties of Musical Ability and their Inheritance (Lecture).

THURSDAY, JULY 16.

SOCIETY OF CHEMICAL INDUSTRY (Annual Meeting) (at Leeds), at 9.30 A.M.—Symposium on Smokeless Fuel:—Dr. C. H. Lander and Dr. Margaret Fishenden: Smokeless Fuel—the Present Position and Future Possibilities.—E. C. Evans: Solid Smokeless Fuels: their Production, Properties, and Use.—F. S. Sinnatt and J. G. King: A Study of the Tars and Oils obtained from Coal.

INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 10.30 A.M.—Engineering, Chemistry, and Research:—Miss H. M. Davis: Electricity applied to Mining.—Miss Isabel H. Hadfield: Some Chemical Problems in the Cotton Industry.—Miss Ethel Bailey: Automotive Research.—At 2.30.—Industrial Welfare and Factory Inspection.—Miss Constance Smith: The Woman Factory Inspector in Industrial History.—Miss C. U. Kerr: The Effect of Welfare Work on Health and Efficiency.—Miss E. E. Wilson: The Possibilities of Advancement for Women in Industry.

FRIDAY, JULY 17.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Meeting) (in Philosophical Hall, Leeds), at 9 A.M.—At 9.30 A.M. (Joint Meeting with the American Institute of Chemical Engineers).—Presidential Addresses by the President of the American Institute, Dr. C. L. Reese, and the President of the British Institution, Sir Arthur Duckham.—At 10.30 A.M.—Symposium on Industrial Water Supply and Stream Pollution:—F. P. Veitch and L. C. Benedict: Wool Scouring Waste Liquors, Composition and Disposal.—Dr. T. L. Bailey: Effluents from Ammonia Plants and their Disposal.—R. D. Littlefield: Distillery Waste Liquids and their Purification.—E. B. Besselievre: Statutory Regulation of Stream Pollution and the Common Law.—Dr. E. B. Higging and J. P. O'Callaghan: The Preparation and Comparative Performance of Base-Exchange Materials in Water Softening.—Dr. T. P. Hilditch: Recent Experience of Doucil in Water Softening.—H. C. Parker: Electrolytic Conductivity and Hydrogen Ion Control.—S. L. Tyler: The Absorption of Hydrochloric Acid and Some Data regarding the Tyler-Vitreosil System.—W. L. Stevenson: The State versus Industry, or The State with Industry.—J. W. Sale: Pioneer Studies by the Bureau of Chemistry on Pollution of Shellfish Areas.

INTERNATIONAL CONFERENCE OF WOMEN IN SCIENCE, INDUSTRY, AND COMMERCE (at British Empire Exhibition, Wembley), at 10.30 A.M.—Commerce and Salesmanship:—Miss G. Burlton: Salesmanship.—Miss L. F. Nettlefold: The Place of the Wholesaler in the Scheme of Distribution.—At 2.30.—Electricity—Domestic Science:—Miss M. Partridge: Producing and Distributing Electricity.—Miss T. J. Dillon: At Home with Electricity.

SATURDAY, JULY 18.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Town Hall, Folkestone), at 11 A.M.—A. E. Nichols: Municipal Works at Folkestone.—E. C. Fawcett: Folkestone's New Sea Outfall Works.

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Evolution and Intellectual Freedom.

THE agitation in the United States over the teaching of evolution is attracting such widespread interest that it has been proposed to build a stadium to accommodate twenty thousand people for the trial of J. T. Scopes, a Tennessee High School science teacher, for having taught the truth of evolution in defiance of the State law. The trial is to open on July 10. The charge of the judge to the grand jury began by reading the first chapter of Genesis as the account of creation which Tennessee teachers must adopt. He pointed out that part of the value of education is mental discipline, and that flagrant defiance of the law by the school authorities would not be a wholesome influence in the State. He insisted that the integrity of the law must be upheld. The main issue, however, will be decided by the Federal Court in its decision as to the right of a State to prohibit the teaching of fundamental philosophical principles.

The defence of evolution has been undertaken by the American Association for the Advancement of Science, which has appointed a committee of three distinguished biologists, Prof. E. G. Conklin, professor of biology at Princeton, Dr. C. B. Davenport, director of the Station for Experimental Evolution, Carnegie Institution of Washington, and Dr. H. F. Osborn, president of the trustees of the American Museum of Natural History, New York, to prepare a resolution upon the subject. The resolution, which has been adopted by the Council of the Association, is as follows:

"(1) The council of the association affirms that, so far as the scientific evidences of the evolution of plants and animals and man are concerned, there is no ground whatever for the assertion that these evidences constitute a 'mere guess.' No scientific generalization is more strongly supported by thoroughly tested evidence than is that of organic evolution.

(2) The council of the association affirms that the evidences in favor of the evolution of man are sufficient to convince every scientist of note in the world, and that these evidences are increasing in number and importance every year.

(3) The council of the association also affirms that the theory of evolution is one of the most potent of the great influences for good that have thus far entered into human experience; it has promoted the progress of knowledge, it has fostered unprejudiced inquiry, and it has served as an invaluable aid in humanity's search for truth in many fields.

(4) The council of the association is convinced that any legislation attempting to limit the teaching of any scientific doctrine so well established and so widely accepted by specialists as is the doctrine of evolution would be a profound mistake, which could not fail to injure and retard the advancement of knowledge and of human welfare by denying the freedom of teaching and inquiry which is essential to all progress."

The American Medical Association has expressed itself similarly in a resolution, passed by its House of Delegates, on the question of the teaching of evolution, "that any restrictions of the proper study of scientific fact in regularly established scientific institutions be considered inimical to the progress of science and to the public welfare."

The American Association is being helped in preparing a defence by the Science League, which was founded last year in San Francisco in order to secure liberty of teaching in American education.

These organisations have to meet a widespread and well-organised attack. The teaching of evolution has already been prohibited by law in Oklahoma and Tennessee. Bills for the same purpose were submitted to the State legislatures in Kentucky and in Texas and were rejected by the Upper House, in Kentucky by a majority of one vote. In Florida the legislature passed a resolution advising the educational authorities not to employ those who teach Darwinism, and the agitation for direct prohibition is still maintained. In North and South Carolina legislative action against the teaching of evolution was defeated, but text-books and teachers who favour evolution are debarred from the State schools. Georgia has as yet no absolute legislation on the subject, but the State Education Committee last July advised the legislature to refuse grants to any school, college, or university that favoured the doctrine of evolution, and it has recently withheld a grant from a State library because it contains books on evolution. Bills against the teaching of evolution are being introduced or have been introduced into the legislatures of the States of Arizona, Arkansas, Georgia, Illinois, Indiana, Iowa, Minnesota, Mississippi, North Dakota, Oregon, and West Virginia.

In California the effort was made, as mentioned in NATURE of May 9, p. 683, to avert a struggle by reference of the question to a committee of the nine

presidents of the State universities and leading colleges. Six of these colleges are under denominational control, and the unsatisfactory compromise previously referred to in NATURE has not satisfied either side. A requisition is being signed for a reference of the question to a ballot at the next election; and the Fundamentalists are said to be confident that they will carry the State, unless books which give even a moderate approval of evolution are excluded from the schools.

The anti-evolution party is being supported to some extent by the publishers. Thus, one distinguished New York biologist has been requested by his publisher to omit any reference to evolution in any new editions of his text-book, owing to the objections of the Southern and Western States. The intellectual terrorism in some of the States may be judged by the fact that according to the *Boston Evening Transcript* of May 23, although, while the anti-evolution Bill was before the legislature in Tennessee, many clergy protested against the proposed infringement of freedom of opinion, "there was never a word of protest from the State University." The North-eastern States show by the comments of the Press their deep regret at this outbreak of intellectual obscurantism, and it is to be hoped that an authoritative expression of opinion there may help the Southern and Western States to realise the heavy handicap they would be laying upon themselves, as well as upon their universities and schools, by the legal prohibition of well-established scientific principles.

In Great Britain, State interference with university teaching would not be tolerated. The proper body to decide what may or may not be taught in a university is the Senate or Council, and not a popularly elected civic chamber of any kind. It must not be forgotten, however, that education authorities in England exercise the right of control over the teaching of religious doctrine in schools, and that they could apply the same powers to the teaching of evolution if they wished. It is not for us, therefore, to attempt to justify what seems to have been a breach of law in the State of Tennessee, however much we may deplore that a State should pass a measure which is contrary to all modern ideas of progressive thought and intellectual freedom. What we are concerned with is the principle by which a political party or organisation should be able to put obstacles in the way of human enlightenment and independent thought, and should have the power of approving, or preventing, the teaching of scientific facts or conclusions of any kind. We have long passed the stage at which this was possible in England, and cannot help being astonished, therefore, that there should be States in the United States of America which deliberately adopt a policy of scientific stagnation.

In order to ascertain the views of leading authorities in the fields of university work, science and religious teaching, upon this attitude, advance proofs of this article have been sent to a number of representative men, whose comments, here subjoined, will, we believe, be read with interest on both sides of the Atlantic.

Prof. WM. ADAMS BROWN, Ph.D., D.D.,
Roosevelt Professor of Systematic Theology, Union Theological Seminary, New York.

MY friend, Prof. Wildon Carr, has suggested to me that it might interest readers of NATURE to learn the views of an American observer as to some of the antecedents of the singular case presently to be tried in Tennessee. The incident, dramatic as it is, is not an isolated event, but part of a movement the beginnings of which go back many years, and has already caused a serious rift in several of the more important denominations; it cannot be understood without reference to its larger setting.

The first factor to be borne in mind is geographical. The United States, in spite of its hundred and ten millions of people, is still, judged by European standards, sparsely settled, and within its ample borders includes populations separated from one another by differences of antecedents, habits, and tastes, scarcely less marked than those which separate the different countries of Europe. There are wide areas of the United States in which the inhabitants know as little of what goes on along the Atlantic seaboard as the inhabitants of China or India. To understand the psychology of Fundamentalism, one must see such a play as "Sun-up," and remember that it truthfully describes the mental attitude of hundreds of thousands of American citizens of the purest English stock.

A second factor to be reckoned with is the tendency of Americans to standardise their thinking. This characteristic, which constantly surprises the English visitor, accustomed to the free expression of individual opinion on every topic under the sun, has its explanation, if not its justification, in the exceptional conditions under which the American democracy has developed its national life. With a people recruited from every quarter of the globe, living under conditions which stimulate individual initiative, there was grave danger that the unity of the national life might be lost unless the variant elements could be held in check by a powerful public opinion. In Great Britain, centuries of tradition have fixed habits of action in certain definite grooves, and one can safely allow himself the luxury of freedom in his thinking

In the United States, where tradition is at a discount, and each man does what the need of the moment seems to require, there must be some steadying and conservative influence, and this, apart from the written constitution, is supplied by a powerful and often tyrannous public opinion. What is going on in religion in the so-called Fundamentalist movement has its parallels in economics and in politics. Feeling is often substituted for reason, and the nonconformist is punished by social disapproval, if not ostracism.

To understand the theological antecedents of Fundamentalism one must go back a generation to the Briggs case, the celebrated heresy trial of the last decade of the last century, which in so many ways paralleled the Robertson Smith case in Scotland. There, as here, the issue was the inerrancy of the Scripture; there, as here, the first result was the condemnation of the accused; but, at this point, the parallel ceases. In Scotland, the result was a revival of Biblical study carried into the homes of the people by a generation of ministers who were teachers as well as preachers—a revival which familiarised the rank and file of the people with the issues involved, robbed criticism of its terrors, and prepared the way for the saner and more scientific theology of to-day. In the United States, this result followed with certain individuals and in certain sections of the country, but for the most part the effect was different. The Briggs case shook the faith of many a minister in the old theology without giving him a firm grasp on the new. He therefore ceased preaching theology altogether and turned to social service or some other practical interest as a substitute. The result is that the present issue comes upon a people unprepared to meet it, and easily swept away by the plausible rhetoric of an orator like Mr. Bryan, who has learned by long practice to make words do duty for ideas.

It must be further recognised that when their real interest is separated from the fantastic opinions with which they have associated it, the Fundamentalists are contending for something with which men of a very different mental outlook may feel sympathy, namely, a positive and constructive Gospel. In the general loosening of old ties which has been the aftermath of the War not a few self-styled liberals have been ready to break completely with the past, and lightly to surrender values painfully won by the labour and sacrifices of many generations. The spectacle of this light-hearted radicalism has seriously alarmed many who would have been ready to respond to a saner presentation of the newer views, and, yielding all too readily to the psychology of the crowd, they have allowed themselves to lend their support to positions which, under less trying conditions, they would be the first to repudiate. It is not the first time in the history of religion that a good cause has been discredited by the agents of which it has made use.

One further point requires brief notice. In spite of the factors I have mentioned, the controversy would not have reached its present acute stage if there had not been on the Fundamentalist side a systematic popular campaign, amply financed, which has carried the cry of the Gospel in danger into every section of the country. Only recently have the advocates of a reasonable Christianity realised the danger which confronted them, and organised for a similar campaign of education on the other side. That realisation has, however, come at last and that organisation been effected, and unless the American people have been permanently bereft of the good sense which has hitherto characterised them in critical hours, we may confidently expect that the forces of reaction will be checked, and a reasonable liberty of thought be safeguarded.

Sir Ray Lankester, K.C.B., F.R.S.
Formerly Director of the Natural History Departments of the British Museum.

In the article about to be published in Nature which you have sent to me for comment, I do not find any definite information as to the law or laws said to be operative in certain States of the American Union by which the teaching of the doctrine of evolution is forbidden, nor do I find any precise statement of the power said to be exercised by certain States of withholding pecuniary support or, on the other hand, of giving it to colleges or schools which teach or do not teach subjects approved or disapproved by the State legislature. One must suppose that such *direct* control of the educational programme of colleges and schools supported by grants from the public purse is approved by the citizens who elect the legislative body. If the wishes of the constituency are carried out, lookers on may regret or disagree with the programme enacted, but must admit that the action is in accordance with the fundamental principles of self-government. If the action is not in accordance with the wishes of a majority of the constituency, that majority can elect new representatives pledged to the policy it prefers.

Another very important question is raised in your article about which I have no information. You say that the Federal Court has the power "to decide as to the right of a State to prohibit the teaching of fundamental philosophical principles." One would wish to hear more about this power of the Federal Court, and also as to the interpretation of the term "fundamental philosophical principles." In the absence of information on these matters it would be rash to pursue the

subject further. Clearly enough (in my opinion) the integrity of the law must be upheld. The "law" can be altered by a regular constitutional method, but there seems to be no justification for disobeying it instead of repealing it.

The normal and healthy result of the exclusion from State colleges of "studies" which many citizens desire to be made accessible for themselves and their young people, must be to bring about a "boycott" of the State institutions in question, and the endowment of free "nonconformist" colleges to take their place. In many respects educational enterprise flourishes best when free from State interference, State prejudice, State ignorance, and State jobbery. The great universities of the United States are independent corporations, and so are Oxford and Cambridge and their colleges, and so too are the other great universities of Britain. The State government does not at the present day presume to control their programme of studies, but rather protects them from fanatical influences and secures them in the possession of property which enables them to pursue the making and the diffusion of knowledge with independence and self-respect. The present freedom of student and professor and the self-governing status of "Universities" in Great Britain is the outcome of long and historical struggle. That status is not theoretically complete even now, but is in a reasonable state of adjustment to the demands of healthy progress. The university is expected in Great Britain to be (and *is*) tolerant of divergent opinions. It unites learned men of various philosophical outlook in a common effort to increase knowledge and to promote its diffusion through all classes of the community.

It must be incredible to British teachers that a judge charges a grand jury by reading out the first chapter of Genesis and declaring that that is the account of creation which Tennessee teachers must adopt. As a matter of *fact* that is *not* what the judge said. What he said was that, according to the law of the State of Tennessee, a teacher could not legally be paid his salary unless he taught the first chapter of Genesis as true. A Tennessee high school science teacher refused to give that teaching, and so has gained an enormous journalistic advertisement.

The whole affair is being worked by journalistic enterprise in the States on a misleading basis. There is no "trial" of the advertised teacher. He is no martyr. He is simply a case of the very ordinary failure of an employee who will not carry out the terms of his engagement and is dismissed accordingly. He is under no compulsion. He can teach according to contract or he can go elsewhere. He prefers to go. The interesting questions which remain for solution are: (1) Do the free and independent citizens of the State of Tennessee approve of the action of their legislature in regard to the first chapter of Genesis? (2) Will the Federal Court over-ride the interference of the State legislature in this special instance? It will take time to educate the citizens of Tennessee so as to enable them to judge whether their legislature is wise or foolish in endeavouring to exclude the teaching of the doctrine of evolution from State-supported colleges. We must wait and see. But in the meanwhile the great colleges of Harvard, Yale, and Princeton and the scientific academies and museums of the United States are not affected by this storm in a tea-cup.

P.S.—I should like to place on record the fact that at Oxford in 1873 I gave, as deputy of the Linacre professor of anatomy and physiology, a course of public lectures on "The Genealogy of the Animal Kingdom," in which I fully accepted and taught Darwin's doctrine of descent. Neither at Oxford nor afterwards when I gave a similar course of lectures at the Royal Institution in London was there the smallest protest or objection raised to the straightforward teaching of the doctrine of evolution and Darwinian zoology. On the contrary, I received warm encouragement alike from professors and undergraduate students.

Prof. E. W. MacBride, D.Sc., F.R.S.,
Professor of Zoology, Imperial College of Science and Technology, South Kensington.

The remarkable movement in America aiming at the suppression of the teaching of evolution in schools and universities is too widespread and has far too much momentum behind it to be accounted for as a mere outbreak of intellectual obscurantism. The general public there, as elsewhere, is profoundly uninterested in scientific speculation, unless this is discovered to have a practical bearing on life. It is because, in the opinion of the average American, the doctrine of evolution as taught in American schools and colleges is liable to defeat the purpose for which those institutions were established that he has risen in revolt against it.

The Fundamentalist argument is as follows:—These schools and colleges from which we desire to exclude evolutionary teaching were established by men brought up in the Puritan tradition, which has largely moulded and developed the American national character, of which we are all proud. The object for which these homes of learning were founded was not the imparting of abstract truth but the training of men to be good citizens. Evolutionary teaching in America has led to a purely materialistic and mechanistic view of life: it teaches that individual men are mere ephemeral bubbles on the surface of things: that their moral ideas are only tribal taboos of no particular validity: that "conscience and

free-will," to quote a leading exponent of "behaviourism," "are mistakes of the older psychology," that "God" and "Heaven," according to another evolutionary philosopher, "are defence-mechanisms different in degree but not in kind from the illusions of the paranoiac," and the widespread acceptance of such ideas would undermine the American character.

The most practical objection to the Fundamentalist position is its entire futility. Nothing could do more to stimulate widespread interest in evolutionary views than the attempt to prohibit them. The American youth in particular resents being forbidden any of the fruits of the tree of knowledge, and the attempt to do so will only whet his appetite for them. Just as hundreds of boys and maidens now indulge in whisky drinking who in pre-prohibition days never dreamt of such a thing, so it is to be anticipated that hundreds of youth who previously were entirely satisfied with cinemas and baseball will become evolutionists.

The only way effectively to combat the mechanistic view is to build up a thorough and convincing idealistic criticism of it. This is the path which has been followed in England; indeed few if any of the great Victorian scientists were blind to the enormous intellectual difficulties involved in a thoroughgoing materialism: for this reason Huxley, amongst others, wisely adopted the position which he termed "agnosticism"—freely acknowledging that problems of the relation of mind to body were entirely beyond the competence of science to solve. Since Huxley's day, idealistic criticism has grown in strength, and so it has come about in Great Britain that all sorts and conditions of men, including reverend bishops of the Church and nonconformist divines, accept evolution, whilst still refusing to accept a mechanistic view of life and the universe. We commend the consideration of these facts to Fundamentalists in America.

Sir Arthur Shipley, G.B.E., F.R.S.,
Master of Christ's College, Cambridge.

The average American of the Middle and Southern States is a very naïve mammal. As a "prominent citizen" tells us in the current number of *The National Review*, the United States is a nation of adult children, and certainly some of the things they do seem to older and more mature countries decidedly childish. The farmers and the Methodist and Baptist pastors of States like Tennessee, Kentucky, Oklahoma, are really convinced that they can make a people moral and religious by enacting laws. But the laws in America are so seldom enforced. Before the War some eight or nine States passed a law by which all lunatics and criminals were to be sterilised, but I believe the law has only been observed in one or two cases. Seven years ago I was sitting next to a very vinegary lady at Desmoines in Iowa. She was jubilant over the Volstead Amendment, and said they would now tackle tobacco, and as soon as they had got that noxious weed out of the way, they would have a world campaign against the drinking of tea or coffee, both of which she understood contained poisons. She closely cross-examined me as to whether the students at Cambridge were allowed to smoke, and when I told her that they were, and that I hoped they did, because we believed in the freedom of the individual, she became almost abusive. But finally I silenced her by saying that she seemed so devoted to liberty that she wanted to take it away from everybody else in order to add to her own store.

Now, in several States there is an attempt to control free thought. In the Churches, America has scarcely passed beyond the region of the Presbyterian prosecution of Robertson Smith nearly fifty years ago. They have heresy-hunts, again an attack on free thought. The Ku Klux Klan movement is largely directed against certain forms of religious faith. They are

> "Fightin' like divils for conciliation,
> An' hatin' each other for the love of God."

But all the laws they pass can be and are evaded, and one has no doubt that in those States that have forbidden the teaching of evolution, evolution will still be taught. Unfortunately, as a whole the people of these "sections" are not a reading people, and seldom soar above a light illustrated magazine, or they would read what they may not be taught. The new text-book with which the Tennessee text-book commission has replaced the one used by Mr. J. T. Scopes states, "In reference to all animals resembling man, none of them are to be thought of as a source of origin of the human species." But, after all, thought is free, in spite of Mr. William Jennings Bryan, if one likes to think that man descended from animals resembling man, it will be very difficult to stop it.

Of course, there is a great deal of money in these proceedings. It will be the making of Dayton, where nothing has ever happened before and there is doubtless an expensive publicity agent with an itching palm. The average European who has not seen it has no idea of the "lobbying" carried on by the more pushing publishers in the United States to get their books adopted. Text-books are remunerative, and whoever has got the contract for these new biology books will probably make a very good thing out of it. In the days of Henry Newell Martin, if he wrote a "Physiology" which was to be adopted as a school book by any State, he had to append a chapter on the

dangers of alcohol, otherwise it had no chance of being accepted. As Kipling says of the American:

Enslaved, illogical, elate,
He greets th' embarrassed Gods, nor fears
To shake the iron hand of fate
Or match with Destiny for Beers.

Of course, now it does not pay to make beer in America, you must substitute synthetic gin for the last word of the couplet, but unfortunately synthetic gin does not scan.

The Right Rev. E. W. Barnes, D.D., Sc.D., F.R.S., Lord Bishop of Birmingham.

The ignorant fanaticism which has led to the proscription of evolution in certain Western States of America is deplorable. As one who values intellectual freedom I am shocked that Anglo-Saxon communities should seek by legislation and prosecution to prevent the spread of knowledge. As a Christian I am dismayed by a movement which opposes a reasonable formulation of the Christian Faith. Cumulative and well-tested evidence has convinced every reputable biological expert throughout the civilised world that man has evolved from an ape-like stock. The normal educated Christian in Great Britain regards the process of evolution as the machinery by which God has created man. Every divine of any eminence among us accepts this point of view. Such acceptance strengthens the Christian position, for it makes the spiritual interpretation of the universe which we derive from Christ more convincingly reasonable.

No part of the teaching of Jesus, as set out in the New Testament, can by the most ingenious sophistry be held to imply belief in the literal truth of the Genesis account of creation. The "Fundamentalists" forget that the Bible is a spiritual treasure-house, not a scientific manual. They ignore the Christian doctrine that the Holy Spirit is still at work among men, leading them to an ever fuller understanding of truth; with a fear that is really anti-Christian, they assume that a fuller knowledge of truth will weaken rather than establish the Christian revelation. The inevitable result of their attempt to repudiate sound science in the name of religion will be that tens of thousands of college boys and girls in America will repudiate Christianity in the mistaken belief that it is bound up with pitiable ignorance.

In England the battle was fought out more than a generation ago. From the blind religious prejudice of men like Pusey, Samuel Wilberforce, and Gladstone (why do political leaders damage their fame by theological obscurantism?) we were mainly saved by the enlightened boldness of the Victorian liberal divines; of Archbishop Temple; of Frederick Denison Maurice, who was never tired of quoting the spirit of Darwin's investigations as a lesson and a model for churchmen; of his friend Kingsley; of Bradley, the Dean who buried Darwin in Westminster Abbey; of Farrar, who preached his funeral sermon; of Canon Wilson, who still survives in honourable old age. But without such men the truth would have prevailed. It will prevail in the long run in the United States. Of what avail was it that the Roman church placed heliocentric treatises on the Index of Prohibited Books? The earth moves: and the mind of man moves also to embrace an evergrowing understanding of the mystery of creation.

Prof. W. J. Sollas, Sc.D., F.R.S., Professor of Geology, University of Oxford.

The action of the State of Tennessee raises a number of questions which it would be interesting to discuss were it not that they are all subsidiary to the one which agitates the minds of all freedom-loving peoples, *i.e.* the right of the State to suppress the teaching of scientific truths. On the subject of evolution there is, I believe, among competent thinkers but one opinion. To put it in a form that will be readily understood by our Puritan friends, all zoologists and botanists are agreed that the creation of species including man, proceeds or has proceeded by way of evolution. This a theory which might almost be regarded as a fact; it is so widely and surely based that it might be ranked as of equal certainty as the revolution of the earth around the sun, a subject which supplies an interesting parallel with the present one if only we substitute Papists for Puritans.

But all endeavours to suppress a truth are as futile as they are false. If natural history is to be taught at all in the schools, then in the end the truth will out. The structure, functions, habits, and distribution of animals and plants are, it is true, subjects of such absorbing interest that lessons upon them, from which all theory is carefully filtered off, are sufficiently attractive in themselves to arrest the attention and engage the studies of a class, but the interrelation of the facts they disclose must inevitably suggest many searching inquiries, and curiosity once aroused will not rest satisfied until it has received an answer. Then if we are really back in the days of the Inquisition the next step which will devolve upon the State will be the institution of an Index Expurgatorius. Short of this the truth will no longer rest concealed.

We reach, then, a stage when the community will arrive at a knowledge of the facts of evolution. Then comes the question—What about its explanation? There we are on very different grounds. It is no secret that Darwin's explanation no longer occupies

undisputed possession of the field, and there are without doubt many distinguished investigators who freely admit that a satisfactory explanation has yet to be found. For myself, I confess that I regard the Darwinian explanation as only a half truth, and I think that the discussion of this question requires wider knowledge and greater maturity of judgment than the schools are likely to provide. It should be left to the universities, and even then the implications of all evolutionary theories should be carefully borne in mind, for the effects of some of them, if rashly introduced into ethics, personal, social, or political, might prove to be disastrous in the extreme.

Sir Arthur Keith, M.D., F.R.S.,
Hunterian Professor and Conservator of Museum,
Royal College of Surgeons of England.

It is in no spirit of levity that I, a life-long student of the human body, would quote here, for the benefit of Fundamentalists, both at home and abroad, a saying of that Master whose teaching they claim to follow: "Father, forgive them, for they know not what they do." For if their desires are fulfilled, the teaching of anatomy will become a colossal system of organised hypocrisy. In every sentence of his lecture, a professional anatomist, who is compelled to base his teaching on the first chapter of Genesis, must sin against the truth which is in him. If the teaching of evolution is proscribed, then the study of the development of the human body must be forbidden by law, for in its development the human body proclaims that evolution is true. Dissection will have to be forbidden; for every one, be he teacher or student, who dissects man's body and compares it with that of apes and of monkeys, has the same truth forced on his perception.

Only penal servitude for life will keep men from searching the records of the rocks and discovering that the earth itself has kept a detailed history of plant, beast, and man, and all of these records shout aloud that evolution is true. All the fossil remains of primitive man, of beings who are almost as much ape as man, will have to be destroyed and all written description of them obliterated if Darwinism is to be undone. The stone implements of ancient man, which have been gathered with such meticulous care from recent pages of the earth's history, will have to be gathered together and solemnly carried to the deepest sea and there sunk. For these silent witnesses carry the history of man and the history of woman tens of thousands of years beyond the days of Adam.

Archæologists must be forbidden to enter Egypt and Mesopotamia, for they are carrying history further back than the Bible allows. Astrology must replace astronomy; alchemy, chemistry; children must be taught that the sun and moon revolve round the earth, if the Bible is to be standard text-book of the modern teacher of science.

Men who propose to bring about such a change "know not what they do." They do not know the world they live in. For what they have set out to do is to turn the hand of the clock of progress back to a point it reached four thousand years ago—to a point when teachers of anatomy assured their students that woman was made out of Adam's twelfth rib. If Fundamentalists push their proposal to the point of practice, they will certainly smash the "rock of ages" but they will leave unharmed the "record of the rocks."

Prof. G. Elliot Smith, M.D., F.R.S.,
Professor of Anatomy, University College, London.

The proscription of the teaching of evolution in any university cannot fail to destroy the influence and in fact the very existence of such an institution. For the purposes of a university are to advance and diffuse knowledge and to inculcate the discipline of the search for truth. To deny it the freedom to cultivate these objects is to eliminate its right to exist.

Such action can do no harm to the theory of evolution: nor can it stifle the spirit of truth. But it does reveal the depth of ignorance and stupidity of those who assume that it is possible in the twentieth century to suppress intellectual freedom and to eliminate the spirit of honest inquiry from any community. Moreover, the ignorance is not merely of science but even more of the lessons of history. This campaign for fettering intellectual pursuits has been pursued with a variety of excuses for more than three centuries. In spite of ephemeral triumphs it has invariably ended in disastrous defeats, injuring the misguided fanatics themselves far more than the cause of truth they are trying to stifle. For it is clear the Tennessee comedy is not concerned primarily with evolution: it is essentially the three-century-old attempt to destroy intellectual freedom. The denial of evolution now occupies the place that even so recently as fifty years ago certain theologians assigned to the claim that the earth was flat and fixed in space.

But the reality of evolution is as certain as the fact that the earth revolves around the sun. The former is as essential a part of all modern biological thinking as the latter is of astronomy. Hence the change of the issue does not help those who are stupid enough to imagine that the fact of evolution can be suppressed.

In 1615 Galileo was summoned before the Inquisition, which unanimously declared his proposition that "the sun is the centre and does not revolve about the earth" to be "foolish, absurd, false in theology, and heretical, because expressly contrary to Holy

Scripture." In spite of repeated humiliations, certain theologians (and especially those in the Southern States of America) only finally abandoned these claims that did infinite harm to their own cause less than fifty years ago. The substitution of the biological for the astronomical issue can only result in adding vitality to the ridicule that is certain to overwhelm these misguided people, who know not what they do.

Prof. W. C. McIntosh, D.Sc., F.R.S.,
Emeritus Professor of Natural History,
University of St. Andrews.

Trained from early days in biology on the shores of the rich Bay of St. Andrews under William Macdonald, George E. Day, and Miss Otté, the translator of De Quatrefages' "Rambles of a Naturalist," and later under George James Allman and John Goodsir in Edinburgh, before the appearance of the "Origin of Species," it has been my fate to witness all the vicissitudes of support and opposition (often with personal knowledge of the men) to which this epoch-making work gave rise. Close occupation in zoology and a disinclination to theorise have prevented personal work in a field so fascinating and so fruitful to many, yet such could not check an impartial judgment of the facts. In Great Britain about fifty years ago, it is true that the leanings for and against evolution were each in turn keenly opposed in elections for certain university chairs. It is long, however, since such straitened views have disappeared, and men of every grade of opinion on the subject have been dispassionately chosen on their real merits, and perfect freedom of opinion afforded to university and other teachers. This experience has not resulted in the lowering of the esteem for what is good, nor has it altered the value of the Bible or of religion, nor has it undermined the moral principles and character of the nation—upon which so much depends.

The breadth of view and the great impetus the evolutionary theory has given to the study of the natural sciences cannot be denied. Its value, for example, is of the greatest importance in grasping the relationships of fossil and recent types of every class, from the simple Palæozoic forms to those of the Pleistocene period. Knowledge is a universal goal, and scientific knowledge especially cannot be hampered by restrictions, however well intended. It seeks truth only and labours long to find it. The teaching of evolution in schools and colleges of the United States was perhaps unknown to many in Great Britain, but the veto of some of the American States authorities against such teaching seems to carry us back to the Middle Ages, when free thought and conviction on certain subjects were fraught with violent opposition and danger. I do not hesitate, therefore, in joining my scientific colleagues in protesting against this infringement of freedom of thought—affecting responsible officials of high character in universities and schools of the United States.

Rev. Hilderic Friend,
Wesleyan Minister.

My biological researches commenced close on half a century ago, when the Churches were almost all strongly opposed to Darwinism. My bias, therefore, was, from the outset, against the theory of evolution. Yet every step taken in the study alike of botany and zoology, of anthropology and religion, tended to show me that the secret of life was to be found, if anywhere, along the lines of evolution; and there was no other theory in the field which could meet all the difficulties involved in the mystery of life. Genesis states a fact, evolution attempts an explanation.

As a student of divinity, long familiar alike with the idea that science and religion were in conflict, and that the doctrine of evolution intensified the supposed antagonism, I have found in that doctrine the most satisfactory solution of my problems as a teacher. I owe much also to the fact that, in my plastic years, I resided in the East, and became familiar with Oriental imagery and modes of thought.

I find the doctrine of evolution in fullest harmony with all that I have been able to discover by practical study of Nature and comparative religion, as well as by personal experience. While I have the highest respect for law and order, I cannot but wonder that the making of laws relating to the education of the race should be in the hands of men so reactionary and ill-informed; men who have failed to learn anything from the past. All history teaches us the unwisdom of opposing new modes of thought. Christ had to insist on a revision of the Mosaic law, as being out of harmony with the thought of the age, and time has in fullest measure justified his action. The Church in vain attempted to suppress the teaching of Galileo. If this thing is of men (as a wise man once remarked) it will come to nought; but if the doctrine be true it cannot be overthrown. The truth will prevail. Nothing can be gained, and much will inevitably be lost, by any attempt to enforce legislation against the teaching of evolution.

It must, however, be conceded that much present prejudice and misunderstanding is due to the want of thought and tact often displayed by propagandists. For the future, in order to obviate these things, the teaching of science as well as that of religion must be entrusted to our wisest, best, and most careful

trained educators. Whatever of error there may then be in their teaching will eliminate itself, and the doctrine of evolution may safely be left in their hands to establish itself if it be true, to develop and unfold if it be imperfect, or to perish if it be false.

F. A. Bather, D.Sc., F.R.S.,
Keeper of the Department of Geology, British Museum (Natural History).

This medieval gesture is curiously half-hearted. Complacently to accept the material benefits of research and to reject the intellectual results, to prefer the electric light to the light of reason, the loud-speaker to the still small voice of the spirit: this is worse than a frank return to the Dark Ages. But the attackers of evolution have apparently never considered what is meant by it. Possibly some of its defenders also have not considered. The attack at any rate is confined to organic evolution (atoms and automobiles may evolve as they please), and the spear-point of it is directed against the statement that man is descended from the anthropoid apes. Few would accept so crude a statement nowadays, but any statement that zoologists could substitute for it would, no doubt, be equally objectionable.

Education, however, is the field of battle, and a teacher may perhaps grant something to the other side. Evolution is a theory of creation. There are other theories, and some of them, held by thousands of well-meaning people, may not be taught in the State schools of certain countries. Perhaps it is just as well not to teach any theories. A teacher who is not himself an investigator is liable to be too dogmatic and to bring forward a theory as a ready-made explanation of matters which he is really (like the rest of us) unable to explain. The right of free thought and free speech is one thing; the guidance of the young is another.

As a palæontologist I should be quite prepared to teach facts, leaving their philosophical interpretation for later years. The intelligent among my pupils would probably come to the same broad conclusion as all palæontologists have come to, and they would have had a better intellectual training than if the theory had been forced into them.

Are not the Americans a little too ready to substitute theory for fact in their educational courses? Perhaps this attack is the inevitable reaction, and it may prove not unwholesome. It would do us all good to drop "that blessed word Evolution" for fifty years.

The controversy will be entertaining and a boon to the newspapers; but is it seriously supposed that all the eminent biologists in the world could convert Mr. Bryan and his friends? As easily would President Osborn convert Mr. Bateson to his particular belief.

D. H. Scott, D.Sc., F.R.S.,
Lately Honorary Keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew.

The resuscitation, in certain of the United States, of the old "Science *v.* Religion" conflict is a curious and interesting phenomenon, which need not seriously disquiet the scientific world. The Fundamentalists are quite right in holding that a belief in evolution is fatal to their own stereotyped form of religion. If religion is to be wholly unprogressive, then science also must be kept stationary; otherwise a collision is inevitable, and science is bound to get the best of it in the future, as she has constantly done in the past.

The surprising point about the American conflict is that it has come so late. Sixty years ago, when Darwinism was young, we were quite accustomed to this kind of antagonism in England, though it does not appear that we ever went so far as to prohibit the teaching of the new doctrines.

It may be doubted whether, among scientific men, there are any now living who reject the theory of descent. From a biological point of view this is, in fact, the only theory in the field, for the old doctrine of special creation was no more than a confession of ignorance. To account for the origin of species by asserting that species were created by the Deity is as if we were to attribute the origin of the Himalayas to the act of God, instead of trying to find out how and by what forces their elevation was accomplished.

It is probable that those who dislike evolution may have been misled and unduly encouraged by the recent frank statements of some eminent biologists, who have acknowledged how little we know of the methods of evolution. The difficulties are no doubt more fully realised now than they were a quarter of a century ago. But Mendelism and its implications no more cast doubt on the reality of evolution than the theory of relativity invalidates the discoveries of Copernicus.

Of late years I have often had occasion to direct attention to the difficulties in tracing the course of evolution in the plant world. The problem is extremely involved, and many questions must be left open. None the less, the general conclusion that the past history of plants, like that of animals, is nothing but the record of an evolutionary process, remains firmly established.

Rev. Frank Ballard, D.D.,
Christian Evidence Lecturer for the Wesleyan Conference.

It is difficult to write with judicial calmness concerning the state of affairs exhibited by the approaching "trial" of Mr. J. T. Scopes for teaching evolution in

the Tennessee High School. The assumptions of Fundamentalism are so preposterous, alike in theory and in practice. I am not altogether surprised, when I call to mind my experiences in America a quarter of a century ago. It was pitifully manifest then, that both in science and theology, many of those who posed as authorities were half a century behind the times. But one did hope that the intervening years would have opened their eyes. The notion of a Judge's charge to a grand jury beginning with the reading of the first chapter of Genesis—"as the account of creation which Tennessee teachers *must* adopt"—of course in the Fundamentalist sense—savours of the sixteenth century rather than the twentieth.

In view of the whole case, there are two questions which loudly call for unequivocal answer. (1) The first is whether universities are to be free to teach what is true, in the light of advancing knowledge, or are to be for ever throttled by the grip of theological obscurantism. Unless this latter alternative be met with an overwhelming negative, humanity must simply drift back to the miserable darkness of the Middle Ages. (2) The other question is whether the view of creation, with all its consequences, which is dogmatically insisted on by Fundamentalists, is so true that nothing more remains to be learned.

It is not too much to say that, in these days, every child in a respectable school knows that it is not. Whatever room and need there may be for the correction of Darwinism, and the re-statement of evolution in the light of our latest knowledge, this certainty emerges, as plainly as the light of dawn after the dark, that the "creationism" which pivots itself in the opening chapters of Genesis is wrong; and its inferences are as false as they are dangerous, as mischievous as they are dogmatic. Neither God nor man is such as the Fundamentalist shibboleth declares. To say nothing of palæontology, biology, and embryology—save that they cannot now be extinguished by ecclesiastical anathemas—every Fundamentalist bears about in his own body a hundredfold proof that his main contention is untrue. That ought to suffice, not only for all the twenty thousand who are to fill the stadium for the "trial" of July 10, but also for every sane and sincere man or woman on earth.

W. Bateson, D.Sc., F.R.S.,
Director of the John Innes Horticultural Institution, Merton, Surrey.

I am glad to add a few words to what I wrote in Nature of September 1, 1923, p. 313. The Tennessee trial is something more than a curiosity in the history of civilisation. Wherever science and learning are valued, sympathy with the unfortunate victims of this new persecution will be unanimous and deep. They suffer in the cause of truth, if ever men did. To them personally we trust that at least some restitution may be made.

None of us can, however, be indifferent to the issues now being raised on a great scale for the first time in the modern world. The opinions of Tennessee and similar communities respecting the evolution of animals and plants would not seem to be a matter of general concern, but the symptom is really one of grave trouble, and the tremor now perceptible is an indication of a strain in the social fabric which sooner or later may end in catastrophe. To the nineteenth century the dissemination and inculcation of scientific truth wholesale was an object almost as desirable as actual discovery. The fundamental and permanent heterogeneity of the population was not appreciated as a fact of any consequence. With education it was expected to disappear. Nothing of the kind has happened. If the true convictions of our own people could be ascertained, I do not suppose they would be found to be very different from those of Tennessee. We are fortunate in having a somewhat larger proportion of the rarer elements as an ingredient in our population—men whose minds are as Plato might have said "released"; but they are a mere fraction in any community, and it is a miracle that they are able to impose a precarious authority sufficient to protect themselves from molestation.

Upon the still larger considerations which lie behind we, as scientific men, are not required to pronounce. Whether a State stands to gain or to lose by the encouragement of intellectual freedom in comparison with others which control or suppress truth is a problem on which political philosophers have exhausted the arts both of eloquence and sophistry. No universal solution, independent of time and place, can be expected. But one thing is certain: that to us our liberty is vital; and to suppose that movements of this magnitude in the United States have no significance for ourselves is to cherish a very dangerous illusion.

Sir Sidney Harmer, K.B.E., D.Sc., F.R.S.,
Director of the Natural History Departments, British Museum.

It is difficult for those of us in Great Britain who have recently taken part in the centenary celebrations held in honour of Huxley, the champion of intellectual liberty, to realise the consequences of a successful attempt to control scientific thought, or to believe that a result of that kind is possible in a great country like the United States, which has always prided itself on being the home of freedom. The danger is, however, a very real one on the other side of the Atlantic, and our scientific colleagues there who are fighting the battle can count on the unanimous support of workers on this side.

Considerable harm has been done in America by the failure to realise that a want of agreement as to the causes of organic evolution does not imply any difference of opinion with regard to evolution itself. The evidences for the origin of animals and plants as we now see them, as the result of evolutionary processes, seem to us, as to our distinguished co-workers who stand for intellectual liberty in America, too plain to be doubted. Even if, like Malvolio, we did not approve the opinion of Pythagoras, we should think too nobly of the soul to wish to convert an honest conclusion on the subject into a legal offence.

Among those who are qualified to speak in Great Britain there can be only one opinion: that the attempt to limit the advance of scientific thought is intolerable. History is full of examples which show that progress cannot be stayed, even if it can be

temporarily arrested. It may be anticipated that the principle which is so much feared by a section of opinion in the Southern States will ultimately triumph over its opponents, by the inexorable evolution of a more rational attitude of mind. In the meantime, much harm may be done, and it may earnestly be hoped that the supporters of a policy of intellectual slavery will be defeated.

Ernest Barker, D.Litt.,
Principal of King's College, London.

How far can the public opinion of a State, expressed through its legislature, claim to control the curriculum or the teaching of universities or schools? It would seem to me that any State may demand that this or that subject should be taught in any place of instruction which is supported from public funds, but that no State is entitled to prescribe what should actually be taught about any subject. The reason is simple. The aim of all teaching is to awaken and train intelligence. No teacher can awaken or train the intelligence of his pupils unless he is using his own intelligence freely. If a teacher teaches what he is told to teach, he teaches by rote a lesson which his pupils learn by rote. Without freedom, he is also without self-respect; without self-respect, he cannot earn the respect of his pupils; and failing to earn the respect of his pupils, he fails to produce any effect upon their minds. All education depends on the free contact of a teacher, teaching spontaneously, with pupils who are attracted by the suggestion of his teaching and drawn thereby into study on their own account. No man can draw others to himself unless he is speaking from himself.

The very genius of liberty which inspires representative bodies, and is the breath of their own existence, must prevent them from killing the genius of liberty which inspires places of education and is the breath of *their* existence. A legislature cannot be told what it is to legislate; a university cannot be told what it is to teach. Public opinion is a great thing; but there can be no healthy public opinion without discussion, and no genuine discussion without a genuine and free education. If a legislature tries to kill liberty of teaching, it stultifies itself—based as it is itself on freedom of speech. If public opinion seeks to stifle freedom of thought and expression, it commits suicide; for public opinion can only be formed by freedom of thought and expression. A democratic State cannot kill liberty or stifle freedom of thought without killing itself and stifling the breath of its own life.

Prof. D'Arcy Wentworth Thompson, C.B., F.R.S.,
Professor of Natural History, University of St. Andrews.

When the wiseacres of the backward States, with their true herd-instinct, take to quarrelling over whether evolution should be taught or no, it is some consolation to think that worse mischief might perhaps be found for such idle hands as theirs to do. If they did no more than forbid the teaching of evolution in their elementary schools, I should even be inclined to agree with them; for I feel myself none the worse that no schoolmaster ever dreamed of teaching Darwinism to me, nor has it ever been among the lessons which my own children learn. Few schoolmasters are really fit to teach it, and children have other fish to fry.

That these good people should insist on setting the Book of Genesis against the "Origin of Species," and should hate the one as they love (or profess to love) the other, is a sadder thing. The lessons of the last sixty years, the philosophy of evolution itself, should help us all to appreciate them both, and to see in the Mosaic cosmogony as noble a poem as ever was in all the world, and a living monument of profound wisdom and very ancient science. The longer I live the more beautiful it seems to me,—the more beautiful and the more vitally and essentially true. The child cannot understand it all; who is there that can? But if it be withheld from him, he is robbed of part of his heritage.

When democratic licence lets these foolish and fanatical men impose their folly on the universities and play havoc with the public libraries, then our American friends and we ourselves may well be dismayed. Dr. H. F. Osborn and his colleagues are smarting under insult and injury, but the protest they have drawn up is moderate in tone and faultless in expression. I admire the restraint they display under the gross provocation they have received. What they want (but they are too courteous to say so) is "a bridle for the ass, and a rod for the fool's back."

Rev. Eric S. Waterhouse, D.D., M.A.,
Wesleyan College, Richmond, Surrey.

The action of certain American states, which have set a ban upon the teaching of Darwinism, is evidence of a curious but frequently-noted fact that, in theological matters, the newer countries are more reactionary than the old. The great majority of clergy and ministers in Great Britain accept the theory of the evolution of species. It has appeared within recent years that some of Darwin's positions are not likely to be sustained; especially as regards the importance he attached to the accumulation of small variations, and to natural selection. But the main position of the evolution of species, as against the doctrine of the special creation of "natural kinds," is well-nigh impregnably based.

Modern Christianity understands that the cause of truth demands absolute freedom of research and statement. The basis of all scholarship is the belief that truth can be attained. Religion must hold that what is true cannot possibly conflict with it. Unfettered search for truth will involve that mistakes are made and errors are accepted as true. But the same process will in time provide also the remedy. Those who hold that Christianity is true should also hold that no scientific or philosophical truth can be detrimental to it, even though such truth may upset ancient dogmas. Conversely, it follows that anything set forth in the name of science or philosophy which is incompatible with those broad truths to which man's religious experience bears witness is to be suspected. Surely ultimate truth must be such as satisfies all our values, intellectual, moral, æsthetic, and religious.

Prof. J. Graham Kerr, F.R.S.,
Regius Professor of Zoology.

The fact of evolution is one which is now verifiable by the student of even elementary embryology, who can observe for himself the successive stages by which any one of the higher animals evolves out of the simple unicellular zygote. In the case of man himself it can be seen that he is for a time provided with gill-openings in the sides of his neck and that he has other temporary peculiarities which would justify his being classed with fishes were only his embryonic structure known. That the process of evolution was characteristic of the past history of the race, as it still is of the individual, is shown by many paragraphs of geological history—the most beautiful of them all being that provided by the rocks of the American continent chronicling the evolution of the skeletal peculiarities of the modern horse. The only persons who can at the present day have honest doubts regarding the broad facts of evolution are (1) those who are ignorant of such facts as I have indicated and (2) those whose conception of God permits them to regard His records, as inscribed in the rocks and in the embryonic body, as a whimsical series of deceptions. If the legislators of Oklahoma and Tennessee belong to the first of these categories, their opinions may be expected to change with inquiry—and I would indeed recommend such inquiry into the facts of Nature as a charming and delightful relaxation from their legislative labours—but if they belong to the second there is, I fear, little hope of modification of their strange, and as they appear to me, somewhat pagan doctrines.

No doubt it might be argued that the main point at issue is not whether evolution is a fact but rather whether thought is to be subject to the control of authority. We have seen of recent years manifestoes exemplifying such control—emanating it may be from Berlin, or from Moscow, or from Pekin, or it may be promulgated by the governing council of some social or industrial organisation. The effects in the way of hatred and war that are liable to result from such policy have been so amply demonstrated in the past, and are so clearly apprehended for the future, that I find it difficult to believe that its open adoption will find any considerable body of support in the United States.

Prof. R. C. Punnett, F.R.S.,
Arthur Balfour Professor of Genetics, University of Cambridge.

To one who has never set foot on the American continent, it is difficult to suggest the real meaning of the curious outburst against freedom of thought which has made its appearance in the Southern States. That it is anything more than a sporadic phenomenon is hard to believe. The firm outer crust of civilisation which has gradually set through the long centuries may at times show local disruption, especially in lands with little tradition of disciplined thinking. Where the will to ignorance exists, the forces of obscurantism may from time to time break out with sudden violence, but that they will ever engulf the globe seems a possibility as remote as the return of the solar system into the nebular phase. After all, it is in his powers of reasoning that man differs most from other animals, and without them he could neither feed nor clothe himself.

This inherent capacity for rational thinking, without which daily life would be impossible, is surely a sufficient guarantee that obscurantism in the long run will never prevail. If we admit so much, it is all to the good that the greatest possible publicity should be given to the trial of Mr. Scopes. It will lead to some interest in these matters on the part of millions to whom, at present, evolution is nothing but a longish word that sometimes appears in a cross-word puzzle. It will bring them into contact with facts, which are at once the best stimulant to curiosity, and the best antidote to obscurantism. Let us therefore hope that the combined enterprise of the newspapers, railways, and cinemas will lead to the erection of an even larger stadium than that proposed. Though the lawgivers of Tennessee may make the angels weep, they hold out a promise of infinite entertainment to a world that is often rather bored with life.

F. A. Dixey, D.M., F.R.S.,
Subwarden, Bursar, and Lecturer of Wadham College, Oxford.

The growing agitation against the teaching of evolution in several of the states of the American Union is nothing less than astonishing. If there is anything whatever that is well established in the conclusions of natural science, it is the general doctrine of organic evolution. The details of the evolutionary process are still matters of legitimate discussion, but as to the main fact that the present aspect of organic nature is the result of evolution, there is absolutely no question among those who are competent to form an opinion on the subject. But even if the doctrine rested upon a less assured foundation of observation and research than is actually the fact, it is no less deplorable that in a civilised country like the United States an organised attempt should be made to check the process of inquiry into the truths of Nature. Whatever excuse there may have been in former ages for limiting the scope of free investigation, and for visiting with penalties those men who ventured to bring their powers of reasoning and observation to bear upon the conclusions sanctioned by authority, no such excuse or palliation exists at the present day.

The futility of all efforts to impede the progress of scientific discovery has been amply demonstrated, and it might have been supposed that this would have been brought home to the consciousness of all but a few fanatics. That the reality is far otherwise has unfortunately been made fully apparent by the activities of the Fundamentalists in the Southern States of America; and it must be recognised that the forces of obscurantism have increased in certain parts of the North American continent to a pitch which actually constitutes a public danger. The fullest sympathy is due to those men of science in the United States who are striving to rescue their country from the reproach of hostility to the cause of truth and knowledge.

Prof. J. Cossar Ewart, M.D., F.R.S.,
Regius Professor of Natural History in the University of Edinburgh.

The coming trial of Mr. J. T. Scopes reminds one of the case of Prof. Robertson Smith, whose articles on Biblical subjects half a century ago greatly distressed and alarmed the authorities of the Free Church of Scotland. Professors in the Free Church Colleges were required before induction to sign the Confession of Faith, which implied, amongst other things, that they would be guided in their teaching by the first chapter of Genesis. After full consideration, Robertson Smith's articles were adversely reported on by a committee of the General Assembly of the Free Church, with the result that he was removed from his chair in the Aberdeen Free Church College. According to Sir Arthur Shipley, the fight made by Robertson Smith for intellectual freedom made him the "most popular if not the most powerful man in Scotland."

There is no evidence that during Darwin's lifetime any professor in the Scottish universities lectured on the doctrine of evolution; but since 1882 the evidence in support of the origin of species by natural selection has been frequently dealt with by teachers in Scotland. It is doubtless true that for some time in Scotland Darwinism was regarded by some as an "unpleasant apparition." This may be partly accounted for by the fact that in 1882 the president of the Royal Society of Edinburgh was a Scottish judge who had no interest in biology, and partly by the presence of several clergymen on the Council. Fortunately, largely by means of courses of lectures in the University of Edinburgh, on the philosophy of natural history, by the late G. J. Romanes, the alarm which for a time prevailed all but subsided; that any opposition that existed has almost entirely died away was made evident by the popularity of Sir Arthur Keith's recent lectures in Edinburgh on the "Story of Man's Evolution as told by his Fossil Remains."

E. N. Fallaize,
Hon. Secretary, Royal Anthropological Institute.

The attempts to discourage the study of evolution which have been made in certain legislatures of the United States, as well as the impending trial in the State of Tennessee, have naturally aroused considerable interest among anthropologists in Great Britain. A ban on evolution would virtually affect the progress of anthropological science not only in so far as it affects the origin and descent of man, but also as rendering meaningless the conception which serves to give unity and direction to the study of human culture as a whole. The importance of these studies in relation to the general advancement of knowledge needs no emphasis, while any system of higher education which omits to take into account the systematic study of man and his culture is deprived of one of its most important elements as an educational discipline. A generation growing up under a scheme of education thus mutilated would find itself cut off from the general stream of intellectual progress and isolated from the culture of the remainder of the educated world.

On the general question of the relation of the State to scientific inquiry, it is impossible not to deplore a movement which seeks to fetter individual freedom of thought and investigation, and at the same time attempts to justify such interference by submission of the questions at issue, not to a scientific tribunal, but to a court composed of laymen without scientific training, and governed by rules of evidence which have no validity in scientific investigation. Should the obscurantist influences which have promoted this action in the State in question prove strong enough to carry the day by force of numbers, the result will appear derisory to the rest of the civilised world; but unfortunately it will deal a disastrous blow to science in the United States, and indirectly to scientific investigation as a whole throughout the world.

Prof. Sydney J. Hickson, D.Sc., F.R.S.
Professor of Zoology, University of Manchester.

A little while ago a student in my class took the opportunity which an examination afforded to dissent from, and to criticise severely, a view which I had expressed in my lectures.

I took the line of action which I think all my colleagues in this country would have taken of giving him a mark for his answer irrespective of the views he expressed, suppressing an inclination I felt to mark him a little higher for the courage he showed in dissenting from the views held by his examiner.

In a university where the teachers are free to teach, the students must be free also to accept or reject the theories they are taught. Suppression of free teaching must lead to suppression of free learning. The students will leave their high school or university trained in the belief that the theories and conceptions of the universe they have learned are true and that anything else is false. This can only lead to a form of mental stagnation in the generation which it is our duty not only to instruct but also to stimulate to search for truth in the wide fields of science.

In the correspondence which has been published about the Tennessee State law on the teaching of evolution, a great deal has been written about the importance of the liberty of the teacher. With all that we must cordially agree. But let us also plead for the liberty of the taught. Let us insist that in a free country the young men and women should be trained to think, encouraged to discuss, and free to form an opinion. The dogmatic teacher produces dogmatic pupils, and a State that insists upon dogmatic teaching produces a race of citizens deprived of that liberty of thought which is essential for its progressive development.

Prof. J. Stanley Gardiner, F.R.S.,
Professor of Zoology and Comparative Anatomy, University of Cambridge.

In all ages and in all climes men have striven for truth, and in the march of progress men have attained no step after more persistence and suffering than the right to a free utterance of the truth that in them lies. Real religion and science have in common this passion for truth, eternal and indestructible. In its search for truth, science begins with the demonstrable

facts, and from these humbly and gratefully draws conclusions. These are not in the nature of permanent dogma, and, as more evidence is attained, further conclusions are drawn.

Let legislators, who ban the teaching of evolution, think what they are doing, and, above all, whether they will not defeat their own ends. The technique of all teaching prepares the ground for theories of evolution. The biologist teaches facts, but the road for the student has already been paved, and the latter naturally strings these facts together in an evolutionary form. I know no professor of biology who requires to teach the broad theory of evolution, for, with a little knowledge of facts, his students, universally and of their own initiative, deduce it for themselves. What the professor does is to discuss how evolution may have come about, its extent and its limitations, endeavouring thereby to teach his students to think logically, that is, sanely. Applied to life his students find that they have learned the principles, not of militant atheism and communism, but of sane and orderly progress, on the due understanding of which depends the prosperity of States. Let those in authority think well of the advice of Gamaliel: "If this counsel or this work be of men, it will come to nought: but if it be of God, ye cannot overthrow it; lest haply ye be found even to fight against God."

Edward Clodd.

The savants of America need no assurance from their brethren on this side of the Atlantic that they are as one with them in their struggle to maintain the liberty of thought and its expression which are the instruments of progress, the legal suppression of which is the aim of the so-called Fundamentalists. That the theory of evolution is based on a bedrock of facts unshakable has no weight where passion, prejudice and ignorance impel undisciplined emotion. Hence, to this type of mentality, reason appeals in vain. Against this are cited the contents of a miscellaneous collection of ancient writings of uncertain authorship, age and meaning, the interpretation of which has riven Christendom into hundreds of "warring sects." We may envy the Greeks of old, of whom, in his brilliant "History of Freedom of Thought," Prof. Bury says, they "fortunately, had no Bible, and this fact was both an expression and an important condition of their freedom."

The attitude of these obscurantist heresy hunters is clear enough. They hold that belief in evolution imperils the souls of men; hence the fanaticism which would prohibit its teaching. To these malignants no quarter can be given: their fictions and fallacies "debase the moral currency." It cannot, as W. K. Clifford says, "be true of my race and yours that to keep ourselves from becoming scoundrels we must needs believe a lie."

Prof. Arthur Smithells, C.M.G., F.R.S.,
Emeritus Professor of Chemistry, University of Leeds.

The control of education by political or sectarian authority must always involve potential danger to intellectual freedom, but it costs an effort to believe that, at this stage of human history and in the New World, we are in the presence of a serious threat on the part of popularly elected State authorities to use political law for suppressing knowledge of the laws of Nature.

It is to be hoped that the intellectual world of the United States will rise to the occasion, and that its members will undergo any kind of martyrdom rather than tolerate so great a scandal. They may be assured of the sympathy and support of multitudes in every civilised country in resisting this extraordinary recrudescence of a type of persecution which was thought to have passed away for ever with the Dark Ages.

The universities, above all, will be called upon to fight on the side of freedom, and it seems inconceivable that they can show any timidity or any willingness to traffic in compromise. The first rights of a teacher, the cause of science, the dissemination of truth, are assailed once more by bigotry and fanaticism in the seats of authority. It seems superfluous to insist upon the importance of the issue or on the need of an unqualified victory over the powers of darkness.

In recent times voices have been heard proclaiming the doom of our modern civilisation. Let learning go into captivity, and surely enough these prophets of evil will be justified!

Rev. J. Scott Lidgett, D.D.,
Warden of the Bermondsey Settlement, London.

The agitation about the teaching of evolution in the United States raises most important political, scientific and theological questions. In regard to them all the controversy appears to me to be disastrous. For a State legislature to attempt to decide questions of scientific evidence is fatal to the interests both of truth and freedom. It extends the authority of the State to realms quite beyond its legitimate province and carries us back to the Middle Ages. From the scientific point of view, the contention that the doctrine of evolution is a "mere guess" is to show complete ignorance of the immense body of facts that have been ascertained, and of reasoning that is secure based upon these facts. What is most injurious of all, however, is the supposition that the truth of Christian Theism depends upon any particular hypothesis as to the method of divine action in creating or constituting, and in sustaining the universe. The philosophy of Theism is much profounder than this. To many Theists, the attempt to treat God as so external to the universe that His action can only be explained as that of Omnipotence acting upon it from without by mere acts of will, is to run counter alike to the deeper teaching of Scripture as to the organic relation of God to His World, to the deliverances of religious experience properly interpreted, and to any satisfactory philosophy of Theism. It represents the doctrine of Deism, and not of Christianity.

Rev. A. F. Day, S.J.,
Church of the Immaculate Conception, Farm Street, London.

Although my opinion on evolution lays no claim to being that of an expert, I feel favourably disposed towards the theory and do not regard it, in any moderate form, as necessarily conflicting with the revealed account of Creation. Even if this were otherwise, the

policy of the Southern and Eastern States could never commend itself to those who have learnt lessons from the past. Indeed, one might well defend Urban VIII. *in re* Galileo—as Huxley did—and condemn Tennessee, Oklahoma and Co. in the present issue. Of course, the teaching of advanced evolutionism lends itself fairly readily to being made the vehicle for communicating an anti-religious bias. To endeavour to inoculate unformed minds with such a prejudice would evidently be taking an unfair advantage. Indeed, such conduct is opposed to science as well as to morality. It is out of place, therefore, even with mature pupils; both science and religion should confine themselves to their respective provinces.

If any one wishes to combat any doctrine which he regards as erroneous, he should equip himself for the task from the armoury of sound knowledge. It is not for the legislature to enter the lists. Nor should the State run the risk of even appearing to repress honest inquiry.

Prof. G. H. F. Nuttall, Sc.D., M.D., F.R.S.,
Quick Professor of Biology in the University of Cambridge.

The leaders of thought throughout the world have for centuries been unhesitating supporters of the principle that intellectual freedom should prevail in university teaching. Therefore, the opposition to the principle which we are witnessing in the United States to-day, in the form of legislation against the teaching of evolution, is of a character which must fill us with apprehension for the future of "the land of the free and the home of the brave," and of the ability of that land to continue thus to describe itself. Involuntarily we ask ourselves, "What next? Where will this end? . . . if the ignorant majority can thus impede human progress towards truth." The resolution adopted by the Council of the American Association for the Advancement of Science will assuredly be approved by all competent men of science.

Sir Oliver Lodge, D.Sc., F.R.S.,
Formerly Principal of the University of Birmingham.

The outcry against the teaching of evolution in some of the United States seems so preposterous in Great Britain that the only use we can make of it is to bethink ourselves whether we are not doing, or wishing to do, or have not done, something of the same sort in connexion with a less established region of scientific inquiry. Actual prohibition may be difficult of accomplishment, but a refined system of boycotting, such as has begun in the United States in connexion with the doctrine and facts of evolution, can be applied with greater ease, and has already been effective in restraining recruits and silencing the utterances of some who might otherwise have been willing to testify to what they know of truth in other subjects. Had Sir William Crookes been a university professor it would have gone still harder with him than it did. *Lehrfreiheit* is only granted with limitations; it is tolerated so long as it does not outrage preconceived opinion and introduce discord into a pre-established harmony.

Rev. S. M. Berry, D.D.,
Secretary, Congregational Union of England and Wales.

All those who have enjoyed an education steeped in the spirit of freedom will hope that the threat to that freedom in the schools of the United States may be averted. The idea that teachers should be prohibited from teaching the doctrine of evolution because it is opposed to a certain interpretation of the Biblical account of the Creation, seems to progressive minds on this side of the Atlantic both ludicrous and preposterous. To the minds of all progressive churchmen, any such prohibition would be regarded as a set-back to religious progress and a denial of that liberty of opinion in matters of religion which it has taken centuries to win. That such a threat should come from the United States is history's latest irony.

Rev. H. B. Workman, D.Litt., D.D.,
Senator of London University, Principal of Westminster Training College.

Any attempt to interfere with freedom in the teaching of evolution is wholly reactionary, and is bound in the long run to be prejudicial to religion. Dogmatism, whether by scientists or theologians, should give place to a greater consciousness of the vast regions of the unknown.

Truth and Doctrine in Science and Religion.

THE vagaries of those near to us in kin are proverbially harder to understand than those of strangers, and it is equally true that it is less easy to appreciate the shibboleths of the generations immediately preceding our own than those of a remoter date. It is undoubtedly a fact that the common element in British culture and that of the United States has often served to obscure certain fundamental differences of which the occasional manifestation sometimes amazes and more often bewilders us. The tendency shown by certain State legislatures in America in their attitude towards the doctrine of evolution, which has culminated in the prosecution of a teacher in the State of Tennessee for the use of a text-book in which a reference to that doctrine was included, is indicative of a public opinion of a force and character which it is difficult for us in Great Britain and in these days to appreciate.

Scientific workers on this side of the water are accustomed to meet their American colleagues on an equal footing. They expect to find among them a readiness equal to their own to accept the facts which scientific investigation may bring to light and an equal openness of mind in the discussion of the bearing of such facts upon accepted theory. It has, therefore, come with something of a shock to them to find that a movement upon which they may have looked with some feeling of amusement, and as such may not have regarded more seriously than as a passing phase, is likely to prove an obstinate barrier to intellectual progress and freedom of discussion. Those who have followed the trend of thought among the intellectual section of the general public in the United States for any length of time may not be equally surprised. They have been aware that sooner or later some such question as this was bound to arise. It is not so long ago that a well-known American novelist put before his

public, as a living question of to-day, in the church of an American city, the problems which exercised the readers of "Robert Elsmere" when first that book was published in Great Britain nearly forty years ago.

The problem with which the more advanced section of intellectual America is now confronted is as old as the hills, or at any rate as old as man himself. Every age and every country produces its Socrates and its Galileo. Everywhere the prophets are stoned when speculation or scientific discovery comes into conflict with the emotions of the majority.

In Great Britain, it is perhaps safe to say that the cause of intellectual freedom has been won. It is not likely that we shall witness again a struggle over a purely scientific doctrine, such as that which raged around the controversies of the middle and latter half of last century. It is difficult for a generation brought up in the freer atmosphere which is a result of those fierce encounters, to enter fully into the intensity of feeling which was aroused by the theological disputes of the earlier Victorian era. The famous Gorham case and the heated discussion of questions of church government which it aroused, and the Tractarian movement, were only a prelude to the storm raised by the publication of F. D. Maurice's "Theological Essays" in 1854, repudiating the doctrine of eternal punishment, which forced his resignation of his professorial chair at King's College, London; while the heated arguments over the archæological discoveries of Boucher de Perthes in the Somme Valley, which relegated man to a vast antiquity, merely paved the way for the tempest which followed the application of the Darwinian hypothesis to the problem of man's origin.

The recent celebrations of the centenary of Thomas Henry Huxley have served to recall the many controversial questions in the discussion of which he was a protagonist; of these, perhaps his encounters with Wilberforce at Oxford, and with Gladstone, have remained most firmly fixed in public memory. To his fearless championship of the doctrine of evolution in the stormy years of the 'sixties of last century, following on the publication of "The Origin of Species," is due as much as to any the victory of freedom for scientific inquiry into, and speculation on, the great problems of the origin and development of the forms of life. His conception of the sanctity of truth, and his fearless acceptance of facts whatever might be their bearing upon dogma in any field of inquiry, remain the creed of the scientific investigator of to-day. But that it is generally recognised as right to hold that creed is due to those who bore the heat and burden of that day—Darwin, Huxley, Tyndall and others of their time. Much must be attributed to the force of personality of those who participated in these controversies, and perhaps as much to the writings of one who took no active part in them himself, namely, Herbert Spencer. Spencer's writings, and particularly his sociological writings, by their application of the biological conception and the evolutionary point of view to the study of man as a social being, did much to secure acceptance for the doctrine of evolution among the intellectual public.

Further, in anthropology the work of Tylor in the comparative study of the beliefs of man demonstrated that behind the great religions of the world there lay a long process of growth which could be traced back stage by stage to the primitive animism of the savage, a work which has been extended and confirmed by the labours of Sir James Frazer. At the same time, the studies of the archæologists, in conjunction with the geologists, were extending to more and more remote periods of time, and to an increasingly primitive stage, the evidence for man's existence, in the shape of the primitive stone implements which marked his early efforts to control and shape his environment to his needs. Concurrently, the critical study of the Bible—the Higher Criticism—was demonstrating the composite character of its parts, while its sources—notably the story of the Creation deciphered by Smith from the cuneiform inscriptions—were being derived from other than Jewish sources.

It would scarcely be worth while to recapitulate these familiar facts if it were not to recall that, immediately following upon the formulation of Darwin's theories and their discussion, there was a convergence of evidence bearing upon the origin and history of man and on his beliefs, some of it derived from an extended application of the evolutionary method of study, which by superseding the traditional static view, tended to facilitate if not the acceptance at any rate the preservation of an open mind towards the central problem.

To the scientific mind, perhaps it is a temptation to over-estimate the extent to which the cogency of an argument has appealed to the general public. The freedom in discussion of matters of the intellect which has been won in Great Britain must perhaps in part be attributed to the national temperament. The key may perhaps be found in the writings of Herbert Spencer, the apostle of the individualism which is the most marked characteristic of the Englishman. The appeal to authority which is the negation of the intellectual freedom postulated by scientific inquiry is by tradition and training alien to the British temperament. The nineteenth century in Great Britain was a time of intellectual ferment in the political as well as the scientific world, but in both cases it was the culmination of a movement which had been in being for centuries. The demand for "Civil and Religious Liberty," which was the war-cry of one of the great political parties of the day, was merely the traditional spirit which gave rise to the Reformation, to nonconformity and to the reforms of the Philosophical Radicals at the beginning of the nineteenth century.

It may be that it was by good fortune that the battle of the Darwinian hypothesis and its extension to the evolutionary theory was fought on favourable ground. That for us of to-day is a matter of history. But it lays upon those who hold the torch to hand it on undimmed and to watch jealously that, in changing conditions, no change can affect the unity of free and unfettered discussion in all matters that appertain to the pursuit of knowledge. In these days, when science is universal and co-operation in scientific research transcends national boundaries, it is impossible that what affects a part should not affect the whole. The whole scientific world will therefore watch with no little interest and anxiety the result of a trial which may by its results affect the intellectual progress of one of the great nations of the world. Not only may it stunt the intellectual growth of generations: it may also debar her from all participation in the advancement of one of the most important of the branches of knowledge.

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