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Science and Leadership.

Among the changes which the British Association for the Advancement of Science has witnessed since its formation in 1831 is the gradual disappearance of the demarcation between science and industry. As Lord Melchett pointed out in a recent address, the endeavour to distinguish between pure and applied science has now lost any kind of meaning. No clear distinction is possible between science and industry. The results of research work of the most speculative character often lead to outstanding practical results. Such progressive firms as Imperial Chemical Industries, Ltd., now follow in Great Britain the practice long current in Germany by fostering close contact with the scientific research work of the universities.

The relation of science to industry was a main theme at the discussions of the British Association at Cape Town and Johannesburg last year, and this year's programme affords further evidence of the interpenetration of science and industry. The discussions on the influence of fertilisers on the yield and composition of plants, on chemotherapy, and on the present position of the British dyestuffs industry, and the addresses to be given on recent progress in air-cooled aeroplane development, on investigations on tar distillate washes, on sugar beet investigations, the bearing of research on improved production of apples, Dr. P. I. du Toit's presidential address on veterinary science and agriculture, and Sir Ernest W. Moir's presidential address on the interdependence of science and engineering, are sufficient evidence that the outlook of modern science is essentially practical and related to the requirements of industry. On the other hand, scientific leadership is now a characteristic of all progressive and prosperous branches of industry. The industries in which the neglect of science has been most marked are those which are most stagnant or most acutely confronted by problems of reconstruction.

If, however, it is true that in the last twenty-five years, science has rapidly assumed the responsibility of leadership in industry, a yet wider responsibility is now demanded of it. Under the conditions of modern civilisation the community in general, as well as industry, is dependent upon pure and applied science for its continued progress and prosperity. Under the influence of modern scientific discoveries and their applications, not only in industry but also in many other directions, the whole basis of society is rapidly becoming scientific, and to an increasing extent the problems which confront the national administrator, whether judiciary or executive, involve factors which require scientific knowledge for their solution. The road traffic problem of to-day, for example, can be traced directly to the enormous expansion in output of motor-cars, and therefore reduction in costs of production, which resulted from chemical research in the field of lacquer solvents. The introduction of oil-fuel for steamers immediately created a problem of waste-fuel disposal, and the layman could not be expected to predict the serious consequences at many of our coastal resorts of the short-sighted policy of dumping waste-oil at sea.

Problems of atmospheric or riparian pollution are all largely problems which have arisen through society using the results of scientific discoveries and their applications, unguided by scientific and unprejudiced investigation of their reactions on the life of the community. Many such problems need not have become acute had an elementary amount of such foresight and scientific investigation been exercised in the early stages of the development of scientific inventions before vested interests had been created.

It is never easy to envisage the full consequences of a scientific discovery, but it is an imperative need of to-day that scientific workers should attempt to predict the consequences of their discoveries and to suggest means of dealing with the probable situation at the earliest and easiest moment. Much useless expenditure of public money, and many unsatisfactory and makeshift arrangements, might easily have been avoided in the past had scientific workers of sufficient foresight and character taken their share in local and national administration. Again, the control of public expenditure on, for example, the National Physical Laboratory or the Chemical Research Laboratory at Teddington in the final issue must be determined by scientific or technical knowledge, and cannot be regarded as satisfactorily exercised by administrators who are dependent on the advice of others for that knowledge.

In recent years the rapid growth in the rate of all kinds of international communication and transport has forced on industry an outlook and organisation that to an astonishing extent are international. These same forces have, however, enlarged the bounds within which mistaken policies can exert their ill-effects. Recent historical research has demonstrated that the difficult racial problems confronting the Union of South Africa to-day are the result of mistaken policies determined by political prejudices three generations ago. In the modern world the dangers arising from mistakes caused by prejudice and neglect of impartial or scientific inquiry are infinitely more serious. In an age when nearly all the problems of administration and development involve scientific factors, civilisation cannot afford to leave administrative control in the hands of those who have no first-hand knowledge of science.

It would be easy to adduce evidence that, in spite of all the increased interest in scientific research manifested by Parliament, science is far from exerting its fitting influence on government and administration. To the precarious position of the Royal Veterinary College and government indifference to scientific representations thereon we have recently alluded. Dr. A. C. D. Rivett, in an article in the *Times* of Aug. 7, has pointed out how neglect of soil science has been responsible for the economic ruin of many agriculturists and the failure of settlement schemes, and the indisposition to accord to scientific workers effective representation on a number of committees appointed in recent years to deal with a wide range of subjects upon which scientific workers could be expected to speak with authority tells the same tale.

Under modern conditions, therefore, more is required of scientific workers than the mere enlargement of the bounds of knowledge. They can no longer be content to allow others to take the results of their discoveries and use them unguided. Scientific workers must accept responsibility for the control of the forces which have been released by their work. Without their help, efficient administration and a high degree of statesmanship are virtually impossible.

The practical problem of establishing a right relationship between science and politics, between knowledge and power, or more precisely between the scientific worker and the control and administration of the life of the community, is one of the most difficult confronting democracy. The community is, however, entitled to expect from members of the British Association some consideration of such a problem and some guidance as to the means by which science can assume its place of leadership.

There are certain factors involved in the establishment of such a relation which are worthy of mention. In the first place, recent events, notably the tendency of the Civil Service to encroach upon the functions of the judiciary, have demonstrated to many what Mr. and Mrs. Sidney Webb (now Lord and Lady Passfield) observed in 1920: " The great mass of government to-day is the work of an able and honest but secretive bureaucracy, tempered by the ever present apprehension of the revolt of powerful sectional interests and mitigated by the spasmodic interventions of imperfectly comprehending Ministers." * One essential condition of progress, therefore, is such a modification of the conditions of entry or recruitment and of promotion in the Civil Service that a reasonably adequate appreciation of the value of science is ensured in the whole personnel of the service, and, on the other hand, that avenues of promotion to positions of high administrative responsibility are open to its scientific officers.

The factor of education, however, is of importance not only in the production of a type of administrator more in keeping with the requirements of the modern world, but also in its influence in the production of a more enlightened type of public opinion and one more competent to sort out the issues. In such work of education scientific workers must take a much larger personal part. Much benefit may result from the mere presence of and contact with men of science in numerous committees, councils, and public bodies forming the machinery of local and national administration, and scientific workers must be prepared to offer themselves for election in much larger numbers than they have done hitherto.

The tendency for governments to overlook the need for adequate representation of science on important committees is at least in part due to the failure of scientific workers to indicate the contribution which they are able to make to the subject under discussion. In another sphere it is difficult to believe that the absence of scientific representation from the Melchett-Turner industrial conference has any other explanation than the failure of scientific workers to make a corporate approach.

A restatement of the claims of science to the attention of the civilised world, or the relation of science to social as well as to material progress, is required, and opportunities for scientific workers to participate in such a campaign of education are by no means wanting. Moreover, the recently formed Parliamentary Science Committee has made it considerably easier for scientific workers to demonstrate to Parliament the contribution science makes to the security and progress of the State and the directions in which that contribution can be expanded with advantage to the community.

The extent of the opportunities and the efficacy of such a campaign are largely determined by the representative character and the political strength of the professional organisations of scientific workers. For this reason the development of such organisations during the last decade is full of significance, not only in affording scientific workers wider opportunities of exerting their influence on public life, but also in raising their status to a point that is adequate to discharge the larger functions which the development of society as well as of industry increasingly thrusts upon them.

It is significant that, in contrast to the relative impotence of scientific workers in national affairs, in the international sphere advisory committees of experts have since the War exerted a remarkable and effective influence even when devoid of all legislative authority. To committees of experts organised by the League of Nations, and exercising advisory functions only, is due the credit of the schemes which were successful in rescuing a European State from bankruptcy and chaos and in handling an unemployment scheme which settled a million and a half refugees, following upon the greatest migration in history. These examples sufficiently demonstrate that, given the requisite stimulus and enthusiasm, the scientific expert can already exert an effective influence when normal administrative effort has failed, and when indeed, as in the case of Austria, the problem had been dismissed by statesmen as hopeless.

In truth, scientific workers occupy a privileged position in society as well as industry, and there are welcome signs that this is now recognised by scientific workers themselves. Thus, in his presidential address to the Chemical Society (at Leeds) last year, Prof. Jocelyn Thorpe suggested that the age is at hand in which the changing majorities of governments will no longer be able to determine major policies, except in directions approved by organised industry, and, in advocating the closer organisation of science and industry, stressed the political strength to be obtained thereby. The paper to be read before the British Association on "The Screening of Southend from Gunfire" is further evidence that scientific workers are accepting the responsibility of leadership in matters of social and industrial safety. Whatever inspiration or encouragement the meetings of the British Association may give to scientific workers in the prosecution of their researches, there is no way in which the Association can more fittingly serve humanity than by calling scientific workers to accept those wide responsibilities of leadership in society as well as in industry which their own efforts have made their inevitable lot.

* "A Constitution for the Socialist Commonwealth of Great Britain", 1920, p. 69.

The Roots of Hellenism.

Who were the Greeks? By Prof. John Linton Myres. (Sather Classical Lectures, Vol. 6.) Pp. xxxvii + 634. (Berkeley, Cal.: University of California Press; London: Cambridge University Press, 1930.) 7 dollars.

HOW and through what ethnic migrations and changes were the essentially Mediterranean, almost Oriental, polity, culture, art, and religion of the Ægean Bronze Age transformed into the very different and distinctly European Hellenism in which western civilisation is so largely rooted? This question has confronted all historians since the discoveries of Schliemann and Evans. The answer elaborated by Prof. Myres in 600 closely reasoned pages is the first really serious attempt to co-ordinate into a single whole the bewilderingly diverse data upon which the solution must depend. He gives us for the first time a comprehensive synthesis of the deductions from geography and climatology, from physical anthropology and prehistoric archæology, from comparative philology and religion, from recently discovered Hittite documents and freshly interpreted Egyptian records, and above all, from the now rehabilitated traditional history of the Greeks themselves as embodied in epic, legend, and genealogy.

The combination of these heterogeneous elements to form the solution of our question may be compared to a jig-saw puzzle: the validity of the solution depends upon the coherence of the resultant pattern; and Myres's work passes the test brilliantly. The solver is indeed aided—but also handicapped—by a certain fluidity in some of the elements, due to ambiguities in the archæological record, obscurities in Egyptian and Hittite texts, or confusions in Greek genealogies: here you adjust the element to fit the pattern; and sometimes the element is missing altogether and the lacuna must be filled up with scientific imagination.

None the less, a coherent pattern does emerge, and very seldom is the fit of any element unsatisfactory. Still more rarely has an element been distorted—and that almost exclusively on the margins of the picture: confusions between mounds of many villages like Rustchuk and sepulchral tumuli, an over-high dating for the shaft graves of Mycenæ, inversion of the relations between Ukrainian and Transylvanian and painted wares and between 'Hallstatt' and 'antennæ' swords, or a perhaps too confident acceptation of Forrer's identifications of names in the Hittite texts, in no wise affect the coherence of the central picture.

To summarise in a short review the results of six hundred pages of detailed analysis would be as unjust to the reader as to the author; the discussions of geographical and climatic controls and the ethnographic and historical parallels worked out in digressions that are embarrassing on a first reading are really as essential to the final picture as the central figures which they help to define. It is not the least merit of the book that it takes full account of the complexity of the problem and does not attempt to simplify the picture by the omission of episodes on the pretext that their effects were transitory.

Passing over the more familiar points in the main narrative, we may direct attention to a few conspicuously original features in this genial work. Most striking is the vindication of Greek folk memory as preserved in the Epics and classical authors against the onslaughts of nineteenth century critics and mythographers. Not only does the author demonstrate the internal consistency of the traditions, especially the genealogies, but he also correlates in an entirely novel manner the crises thus disclosed with dated points in the archæological record. Thus in the Argolid the genealogical date for the first king whose name looks obviously personal, and not merely eponymous or toponymous, coincides fairly well with the beginning of colonisation by Minoan dynasts symbolised by the shaft graves of Mycenæ. (The discrepancy could be better overcome by shortening the generations than raising the date of the tombs.) The great reaction of the Mainland against Cretan domination which resulted in the sack of the Minoan palaces about 1400 B.C. coincides even better with the slaying of the sons of Ægyptus by the daughters of Danaus in the generation of 1400 (Minoan alliance with, if not dependence on, Egypt is clear enough from archæological and hieroglyphic evidence).

So, too, the accuracy of Homer's picture of Achæan society and life is demonstrated along the lines laid down by Allen and Chadwick, but with a fuller mastery and wider use both of the archæological material and of the data supplied by Egyptian and newly discovered Hittite documents. Politically, the Homeric age was a period when foreign dynasts from overseas, Phrygian rather than Hellenic, ruled over Minoanised Greeks as a loosely federated feudal aristocracy. Archæologically, it witnessed the gradual substitution of cut-and-thrust swords for rapiers, of round shields with body armour for long shields, and of iron for bronze.

Very original, too, is the treatment of the fibulæ as illuminating the complex phenomena of this transitional period. Myres regroups several of Blinkenberg's types into larger units the distribution of which is shown to correspond respectively to the area affected by the sea raids mentioned in Hittite and Egyptian documents, to that of the similarly attested land raids into the heart of Asia Minor, and to the Achæan confederacy under foreign dynasts in mainland Greece. The uniformity of the early types in the last-named region is such as to imply quite intimate intercourse between the peoples from Thessaly to Laconia. Yet, apart from their foreign rulers, these peoples must already have been speaking distinct dialects, ancestral respectively to the Ionic, Æolic, and Arcadian of classical times. Myres ingeniously suggests that the 'mixed dialect' of Homer was such a *lingua franca* as was needed to facilitate intercourse in the conditions described. With the break-up of Achæan domination after the Trojan war, specialised local types of safety-pin grow up to symbolise the interruption of intercourse.

The Dorians, too, are recognisable by a special type of fibula, the spectacle brooch, but they did not bring it, as has been usually assumed, from the far north; for Myres would seek their cradle where Greek tradition located it in the peninsula itself, on the north-western fringe of the Achæan confederacy. Nor was the geometric style Dorian, as is generally believed. It was rather the creation of potters, trained in the old Mycenæan tradition, but working for a new public, the product of that dark age of migration the social conditions of which Myres reconstructs most brilliantly. In this style the concentric circle ornament is indeed a contribution from beyond the Balkans, brought by those Lausitz invaders whose presence in Macedonia has been demonstrated by Heurtley and myself. But the Lausitz invasion was just an episode of which Greek tradition preserves memories that lesser authors find it convenient to ignore. The invaders were not Greeks but Thracians, a view which agrees well with my independent conclusions as to the linguistic affinities of Lausitz folk in the Danube valley. Apart from the concentric circle enhancement, the geometric style is essentially Ægean and reaches its highest development in the region least affected by post-Mycenæan intruders, namely, Attica. But in its development the guiding spirit is no longer Minoan or Mediterranean but Hellenic, as Myres shows in a masterly analysis of its content and rhythm. Peculiarly suggestive is his comparison between the rhythm of vase painting and Greek versification. Here lies the clue to the initial question. But to use it the reader must turn to the actual book and read and re-read its arguments, even when they seem irrelevant or repetitive.

V. Gordon Childe.

The Importance of Morphology.

Studies on the Structure and Development of Vertebrates. By Prof. Edwin S. Goodrich. Pp. xxx + 837. (London: Macmillan and Co., Ltd., 1930.) 36*s*. net.

THERE is a peculiar irony in the fact that the method of investigation which in the nineteenth century was responsible for the greatest revolution ever effected in man's outlook and appreciation of his own place in Nature should at present be despised and rejected by so many biologists. The publication of a new treatise on morphology is a challenge to the widespread attitude of depreciation of the value of such studies. Perhaps the question at issue can be best defined by a concrete illustration.

During the present century, many hundreds of experimental and clinical investigators have been occupied in the attempt to discover the means whereby co-operation is effected between the pituitary body and the hypothalamus. Yet the unifying device is visible to the naked eye. Prof. Gregor Popa and Dr. Una Fielding have recently described (*The Lancet*, Aug. 2, 1930, p. 238) a hitherto unnoticed and unique series of vessels for conveying to the hypothalamus the colloidal material elaborated in the pituitary, which are virtually the ducts of the hypophysis, the channels in which blood serves the hydraulic function of moving the colloid upward into the brain. This is merely one example of the importance of morphology for the solution of problems of function, and a hint of the risks to which biology would be exposed if what Prof. H. S. Jennings (*Science*, July 30, 1926, p. 98) has called the 'phobia' of antagonism to morphology should be permitted to dominate our work.

It is the business of every department of science to lay a sure morphological foundation upon which to erect the edifice of knowledge. Whether the subject of investigation be the structure of the atom, the anatomy of a crystal, the plan of an engine, or the architecture of a living organisation, the fundamental consideration is obviously a question of morphology, the neglect of which would stultify any attempt to solve the problems. The physicist, the chemist, the engineer, and the palæontologist do not waste their time in denying the importance of a department of their work which is so essential for the success of their efforts. Yet at the present time we are face to face with the paradoxical phenomenon that many biologists want to repudiate the particular instrument of their subject, which in the hands of Charles Darwin effected the most complete revolution that has ever been made, not merely in the interpretation of living plants and animals, but also in the whole attitude of man to the universe and to the character of his knowledge and sympathies. It is important not to ignore the fact that although Darwin's ideas were in large measure inspired by studies in field biology, in the geographical distribution of plants and animals, and in breeding experiments, his demonstration was based, as he himself so clearly emphasised, on morphology, which in "The Origin of Species" he called "the soul of natural history".

In emphasising the importance of morphology and the danger of neglecting the direct appeal to the observation of concrete facts, however tedious and laborious such a discipline may be, this attitude must not be supposed to involve any failure to recognise the vital importance of the experimental inquiry into the manifestations of life. Most people admit the major interest of the working of a machine and the results which accrue from its use in comparison with its mere structure. But the fascination of watching an aeronaut 'loop the loop' and perform other 'stunts' does not relieve the engineer of the necessity of investigating essential problems of aeroplane construction. Yet there is a widespread tendency to adopt such an attitude in biology—a tendency that is encouraged by the vast importance and brilliance of the results which can often be obtained quickly and easily by experiment. In biology, however, the laborious drudgery of morphological research is a necessary part of most investigations. Moreover, it is a profound mistake to pretend, as not a few zoologists are now doing, that the field of morphology, which has yielded such rich harvests in the past, has been exhausted and is now sterile. It should not be forgotten that a relatively small proportion of the problems of biology is susceptible to inquiry by experiment in comparison with the vast field for research in morphology. The methods which established the fact of evolution have even vaster opportunities for achievement in the future. Almost every discovery in physiology creates new problems for the morphologist — most advances into new territories need for their complete establishment the translation of the results into terms of structure and structural changes. The whole range of palæontological inquiry is primarily morphological.

The attitude of mind that is expressed in the morphology-phobia often assumes a more extreme form in minimising the value of things that can be seen with the naked eye. It is sometimes assumed that anatomical work that does not involve the use of an oil-immersion lens is necessarily futile. The prevalence of the practice of resorting to histological devices before the object of investigation has been thoroughly examined by the naked eye or with a hand lens is responsible for large gaps in our knowledge and a vast number of conventional errors. Not long ago a distinguished surgeon came from Europe to ask for permission to dissect muscles in the human body to compare the lengths of active flesh in the flexors and extensors. When asked why he undertook so long a journey to do what he might equally well have done in the laboratory of his own university (within ten minutes' walk of his house) he replied: "If our professor had an elephant to dissect he would begin by cutting it into sections 10μ thick." This absurd remark unfortunately expresses quite truly the irony of the attitude that is now so prevalent. Even if it be admitted that much of the distrust of morphology may be due to the narrowness and futility of some of the academic morphology of a past generation, this is no excuse for the widespread fashion of depreciation.

It would be possible, if it were desirable, to cite many instances of experimental research the results of which have been utterly stultified by the neglect to take into consideration questions of morphology. What vast accumulations of erroneous inference still encumber the literature of biology because considerations of phylogeny and homology have been ignored! Obvious as they are, these things needed saying to make plain the value and importance of such works as Prof. Goodrich's "Studies on the Structure and Development of Vertebrates". He set out to write a treatise to expound the present state of our knowledge of the comparative anatomy of vertebrates. More than half the volume is devoted to the skeleton, and 512 of the 754 figures with which it is generously illustrated. This is due, not to the assumption that the other parts of the organism called for a less elaborate treatment, so much as the fact that the attempt to deal with them with the same thoroughness would have taken a lifetime to accomplish.

Prof. Goodrich has performed a very useful service in providing the advanced student of zoology and those engaged in teaching and research in comparative anatomy with trustworthy guidance to our knowledge of the vertebrate skeleton. As it includes an account of the fossil remains of extinct animals, the book is also a treatise on vertebrate palæontology, perhaps the most illuminating and comprehensive work that has been written on that subject. The discussion of the skeletal remains of a large series of extinct animals by a zoologist who is also giving the results of his own investigations on living representatives of the same groups provides a more vital and illuminating interpretation of the fossils than a work dealing with the latter alone. Such a mode of treatment minimises the risk of ignoring the fact that the bones were once clothed with muscles as parts of living creatures. The study of palæontology in association with the anatomy of existing animals represents the essential foundation of evolutionary inquiries. It emphasises the vast significance of morphology as the only key at present available to unlock the mysteries of phylogeny and evolution.

The rest of the book is devoted to the gills and gill-slits, the heart and vascular system, the air-bladder and lungs, the cœlom and diaphragm, the excretory organs and genital ducts, and a brief chapter on the peripheral nervous system and sense organs. No attempt is made to deal with the central nervous system.

In his preface Prof. Goodrich emphasises the fact that his book " is not a complete treatise, but deals with certain subjects and problems of special interest and importance, some of which receive but scant notice in current text-books ". This qualification applies not only to the subjects chosen for discussion, but also to his method of dealing with them. Thus his excellent description of the comparative anatomy of the heart, based largely on his own researches, omits any account of the fascinating problem of the connecting systems (the atrio-ventricular bundle).

The difficult questions involved in the evolution of the diaphragm are discussed with great clearness, and, as the author explains with reference to the book as a whole, the lacunæ in our knowledge are defined, but no hasty attempt is made to hide them by premature conclusions.

The least satisfactory part of the book is the final chapter. Perhaps the author would have been better advised to have deferred it until he was ready to link his account of the peripheral nervous system with that of the central organs. The use of the term ' visceral motor ' for nerves which supply voluntary muscles of striated type, wholly dissociated from any viscus, is very misleading, even if it is still fashionable among American neurologists. For more than thirty years it has been the practice among most anatomists to distinguish this group as ' lateral somatic ', and repeated protests have been made against the application of the word ' visceral ' to it.

Prof. Goodrich claims (p. 784) that, while the division of the autonomic nervous system into sympathetic and parasympathetic may be justified on physiological grounds, it is not satisfactory from the point of view of morphology. If, however, the morphologist should differentiate the autonomic fibres, as he suggests, on the basis of the paths—anterior or posterior nerve roots—by which they emerge from the central nervous system, the result will be, not only chaos, but also bad morphology. Clearly homologous fibres in different vertebrates would then have to be placed in different groups. Even in the same animal the cephalic fibres of the accessory nerve would belong to the dorsal root system, from which the caudal fibres of the same nerve would be excluded, although they do not fully acquire the right to inclusion in the ventral root. These considerations reveal the impracticability of Prof. Goodrich's suggestion.

The book in most respects is eminently conservative. In his classification of vertebrates, for example, Prof. Goodrich includes the Tarsiiformes in the sub-order Lemuroidea, although for more than thirty years the need for a special sub-order Tarsioidea to express the admitted facts of morphological distinction has been widely recognised.

These, however, are relatively trivial blemishes in a great achievement, upon which Prof. Goodrich is to be heartily congratulated. The conspicuous quality of the book is the fullness and impartiality of the statement of the present state of our knowledge of vertebrate morphology and the sources of information. Every student of zoology and palæontology should be grateful for this eminently useful book. The excellence of the illustrations, of which there are as many as 754, and the valuable bibliography and scheme of classification of vertebrates are features of the book worthy of special mention.

G. Elliot Smith.

Science and the Layman.

(1) *The Mechanism of Nature: being a Simple Approach to Modern Views on the Structure of Matter and Radiation.* By Prof. E. N. da C. Andrade. Pp. xii + 170. (London: G. Bell and Sons, Ltd., 1930.) 6*s*. net.

(2) *Matter and Radiation: with Particular Reference to the Detection and Uses of the Infra-red Rays.* By John Buckingham. Pp. xii + 144 + 8 plates. (London: Oxford University Press, 1930.) 7*s*. 6*d*. net.

THE ignorance, in matters scientific, of the average intelligent and educated layman is one of the more curious and perturbing features of the age; curious, because science, mostly without intention and as a mere by-product of its activity, has done more to change the structure of society in the last fifty years than statesmen and reformers in all the preceding æons; perturbing, because the discoveries which the scientific worker drops so casually into the stream of knowledge have potentialities, for good or evil, so vast that it seems vitally important that those who are called upon to lead and direct society should have at least sufficient knowledge of the matter to enable them to appreciate these potentialities, and to direct them into wise channels.

Perusal of publishers' catalogues, or of the reviews which appear from time to time in this and other journals, might lead one to suppose that this need had been adequately foreseen and catered for. The fact remains, however, that this large amount of quite competent effort has on the whole failed in its object; the average layman remains still curious and still unenlightened. It is not interest that is lacking. Most of us can, no doubt, recall what should have been pleasant social functions, which have been turned for us into something approaching the horrors of the inquisition by the entirely sincere demands of our friends that we should explain to them some recent achievement in our particular branch of science. The difficulty which almost invariably arises on these occasions and turns what should be a pleasant and grateful task into something like a nightmare, is to find some common basis of knowledge to which we can refer. As Prof. Andrade puts it, in the preface to his admirable volume, "The task is rendered extremely difficult by the fact that the questioner is without the first beginnings of a knowledge of the matter and the method of the science, and is, as it were, like those chemical compounds which are apt and, so to speak, anxious to absorb the vapour of water, but cannot do so easily if they are already very dry; they require a preliminary infection with moisture if they are to drink in with facility a further store". Prof. Andrade's book has been written with the object of providing this necessary preliminary infection with physical science.

(1) "The Mechanism of Nature" is thus an attempt to give the uninitiated but not unintelligent reader an outline of classical and modern physics, to indicate its aims and methods, to expound its basic discoveries and principles, and to show the inter-relations of its various parts. After a preliminary chapter explaining the objects and methods of physical research, the author deals in four brief chapters with the essentials of the four main branches of physics—heat, sound, light, and electricity; and in two concluding chapters with the quantum theory and the atom. To pack so much material into so brief a space might appear to involve an almost impossible degree of compression, but there are no signs of compression or inadequacy in the text. The argument marches steadily step by step, the sentences flow easily, and there is a wealth of pithy but pointed illustrations and similes, which (with or without acknowledgment) we shall certainly see quoted again. So far as it is possible to deal intelligently and intelligibly with a technical subject in non-technical language, the language of the book is non-technical. There is not a single equation to frighten the most timid of readers, nor a single diagram to remind him, perhaps unpleasantly, of the text-books of his youth.

How much will the non-scientific reader carry away from his perusal of the book? It is a little difficult for the scientific reviewer to judge. He will at least realise that Prof. Andrade writes with distinction, and that the subject on which he writes is one which is worthy to occupy the attention of men of culture. If he does not further carry away with him some genuine appreciation of the purpose and content of physics, he may well be advised to give the matter up in despair; he is not likely to encounter an abler guide. "The Mechanism of Nature" is, in short, an exposition of physics which the physicist can recommend with confidence to his non-scientific friends, and by which he may be well content to have his subject judged.

(2) "Matter and Radiation" cannot be recommended with anything like equal confidence. Mr. Buckingham has not Prof. Andrade's art of exposition, and his rambling and pedestrian style makes tedious reading, even where the subject matter is interesting. This is regrettable, because in his two concluding chapters, on the detection and uses of

infra-red radiation, the author has a fascinating subject, and much that he has to tell will be new not only to the general reader but also possibly to some physicists. In this part of the book he writes, if not with distinction, at least with authority and knowledge, and he quite obviously knows so much more about the subject than he has chosen to tell us that he whets rather than satisfies our appetite for information. We could wish for more details than he allows us. It is these later chapters which contain the gist of what the author has to say. The earlier chapters, though they give the title to the book, are but by way of preface, a preface which struck us as being neither particularly well arranged nor particularly well expressed. Mr. Buckingham does not appear to have the proper touch for that kind of writing. We should, however, like to hear more about infra-red rays.

The Mendip Lead Mines.

The Mines of Mendip. By J. W. Gough. Pp. x+269. (Oxford: Clarendon Press; London: Oxford University Press, 1930.) 15*s.* net.

THE observant traveller who crosses the Mendip Hills cannot fail to notice the broken ground, so-called 'grubby or gruffy ground', which his map tells him represents the scene of ancient lead workings. Efforts to acquire fuller knowledge of these met with only partial success until the appearance of Mr. Gough's book, which obviously fills a definite want. The Mendip lead mines date from at least the second century B.C.; they have had a lengthy history, not without many vicissitudes. A good deal of the mining followed veins running near the surface, working either shallow trenches a few feet deep or small pits close to one another running in lines across the fields. The principal lead ore was galena.

In Elizabethan times calamine, a carbonate of zinc, was also worked in the Mendips, and this ore was of much importance in the middle of the eighteenth century when the lead industry was sinking.

The story of a mining field worked for two thousand years is full of interest in every direction. We know from Pliny that Britain became the chief source of lead in the Roman Empire: it was found at the surface of the ground so abundantly that a law was spontaneously passed to limit production. The mines were worked by slave labour or prisoners of war; they were imperial property and their produce was stamped with the Emperor's name; from time to time pigs so marked have been found. The Roman headquarters were at Charterhouse, but very little is known about the site.

Naturally, there has always been conflict between the miners and the farmers, particularly over such questions as common rights and the very serious risk of lead poisoning due to stream pollution or the escape of fumes during smelting. Mr. Gough tells us of some of the troubles during the sixteenth century and later; he further leads us on a side issue into the subject of dowsing for metals, which persisted from the date of its first mention about 1638 down to the last days of the mining industry.

Of the mines in the Middle Ages the knowledge is fragmentary, monotonous, and mainly financial. For a long time they were leased to the Bishop of Bath. Almost nothing is known about the methods of mining and smelting, though there is plentiful information available about the silver-lead mines in South Devon, no doubt because they were Royal mines. The Mendip industry had its own laws and customs, with special courts to enforce them.

Lead mining was at its pride between 1600 and 1670, when every foot of any rich patch of ground was exploited to the utmost, workmen digging pits within a few yards of each other; this is the explanation of the condition of the ground to-day with its profusion of mounds and hollows. Disputes were endless, as the records of the courts show, but the mines were never monopolised by any one big firm such as the Mines Royal which owned all the copper mines in the Lake District.

Our technical knowledge of the mines at this time is due to an elaborate list of questions published in the first number of the *Philosophical Transactions* of the Royal Society, by Boyle, entitled "Articles of Inquiries touching Mines". It was answered by Joseph Glanvil, the vicar of Frome, in two papers which appeared in the second and third volumes of the *Philosophical Transactions.*

By 1680 the readily accessible lodes were exhausted as the result of this intensive working and the deeper pits were much troubled with water flowing into them: various efforts were made to combat this, but none of them achieved commercial success. In later years the poor quality of the Mendip lead in comparison with that from Derby or Flintshire made it impossible to carry the heavy overhead charges of modern appliances. In the nineteenth century the Mendip lead, which contained arsenic, was practically all used for making shot in Bristol; it was too hard for the London plumbers to use for sheeting.

The ancient courts with their executive officers, the records of which tell us so much of the financial and administrative work, disappeared together with the mines. Both lead and zinc had been kept going by a system of protection, and with the advent of free trade their days were numbered, though in any case the old-fashioned individual shallow mining could not have long persisted.

The long story of the Mendip mines is an attractive one, embracing many fields of science, well worth the telling in detail. Our epitome has indicated the breadth of Mr. Gough's treatment, and he is to be congratulated on the thoroughness of his achievement. E. F. ARMSTRONG.

Our Bookshelf.

(1) *Fortschritte der Geologie und Paläontologie.* Herausgegeben von Prof. Dr. W. Soergel. Band 8, Heft 24: *Die tektonische Entwicklung eines Schollengebirgslandes* (*Vogelsberg und Rhön*). Von K. Hummel. Pp. viii + 234 + 3 Tafeln. 18 gold marks. (2) Band 8, Heft 25. *Das varistische Bewegungsbild entwickelt aus der Inneren Tektonik eines Profils von der Böhmischen Masse bis zum Massiv von Brabant.* Von Hermann Scholtz. Pp. ix + 235-316 + 8 Tafeln. 15 gold marks. (Berlin: Gebrüder Borntraeger, 1929 and 1930.)

Two new parts of this serial form interesting contributions to the geology of south-western Germany and the Rhinelands. They both illustrate the increased recognition of the direct influence of earth movements on topography.

(1) Prof. Hummel of Giessen deals with the Vogelsberg in Upper Hesse and the Rhön Mountains along the western frontier of Bavaria and Thuringia, and shows how their topography is dominated by block movements. The area includes the extensive basaltic eruptions to the north-east of Frankfort, and he discusses the relation of the tectonic and volcanic processes. He considers the northern end of the rift-valley of the Rhine, of which the margins have been raised by uplift. Though the main direction of the fractures and rift-valley of the Rhine is to the north-north-east, the course of the valley is modified by the Variscan folds and in part takes their direction. The river system of the Upper Main, however, is less dependent on the tectonic structure than on the basalt eruptions, as the streams are mostly radial from the volcanic piles. The work is accompanied by three maps illustrating the relief of the Vogelsberg and the Rhön Mountains and the relations of the volcanic rocks of that area to the river system.

(2) The monograph by Scholtz is a study of the distribution of various pressure phenomena among the older rocks from Brabant to Bohemia. He classifies them into three types, cleavage, pressure-fractures (*Schubklüftung*), and cross-fractures (*Querklüftung*); he describes these structures in detail, and shows their relation to the Variscan and Alpine movements. The work is well illustrated by photographs, diagrams, and maps.

Annual Survey of American Chemistry. Vol. 4: July 1, 1928, to December 31, 1929. Prepared under the Auspices of the Division of Chemistry and Chemical Technology, National Research Council. Edited by Clarence J. West. Pp. 549. (New York: The Chemical Catalog Co., Inc., 1930.) 4 dollars.

THE object of this survey is "to present throughout a period of years a complete survey of American chemistry", not, it will be noted, an American survey of chemistry, quite another and a much more acceptable thing to non-American chemists. The endowment of science with a national label would be open to criticism even were it admitted that chemical progress, like creative art or even mechanical invention, can be so characterised. In point of fact, one step depends too much on the success of another; moreover, the search for fundamental truth in scientific fact, whether it proves a source of strength or weakness, a curse or a blessing, according to the use made of it, is as little concerned with political frontiers as is the legislature with the laws of thermodynamics. Hence whatever value the series under review possesses—and its value in certain directions is not denied—the survey can scarcely be regarded as a significant contribution to the world's literature of chemistry. The limitation of its general value is admitted in the foreword: "The progress in any branch of chemistry is not confined by the boundaries of any one nation", whilst the sentence which follows exhibits a proper sense of patriotism: "This fact means that in a short time fundamental progress abroad is reflected by the work carried on in America. Therefore a careful annual survey of American chemistry possesses only a certain lag. . . ." Incidentally, however, not all the authors mentioned are United States citizens, and not all of the journals cited are of American origin. The present volume covers a period of eighteen months in order that succeeding volumes may review a calendar year instead of a fiscal year. There are 43 chapters covering a great variety of subjects in pure and applied chemistry, and an author index is appended. A. A. E.

The Sea. By H. A. Marmer. Pp. x + 312. (New York and London: D. Appleton and Co., 1930.) 10*s*. 6*d*. net.

THERE are many popular books on the sea, but they commonly err in trying to combine its science in a single volume. The physics and chemistry are often so cut down that the biologist is not given the basal facts on which the understanding of his problems depends, while the general reader is left with almost nothing. The author of the volume under notice, who is assistant chief of the famous Coast and Geodetic Survey of the United States, omits biology altogether, and the result is a most readable volume that should appeal to every traveller.

The volume is written simply and sincerely, and has all the requisite illustrations. The Sargasso sea is mentioned for its extraordinary clearness, a white disc being visible when lowered to 200 ft., its high temperature and salinity, and its relative motionlessness. Its weed is in small patches, and, while sometimes reinforced from the shallow reefs, ordinarily propagates vegetatively. The depths of the sea should shortly be better known by sonic sounding, which has already given us 35,400 ft. (6·7 miles) near the Philippines. It also suggests that the gentleness of relief of the sea bottom has been very greatly overestimated. The yearly, monthly, and daily variation in sea-level is brought out and clearly requires careful study. The tides are treated well, but we miss the familiar world chart, which serves to explain their origin and curious effects found in the North Atlantic.

We should have welcomed a discussion of the tidal currents in relation to depth and obstructions. A fuller account of 'the waters of the depths' and of their circulatory movements would excite the imagination of the reader. The genesis of the Gulf Stream, the earth's magnetism, and the characters of enclosed seas and their opening straits occur to us as 'larger features' than 'Legendary Isles' and accounts of polar explorations. A chapter on the U.S. Coast and Geodetic Survey would also be of interest as it would necessarily contain the history of the modern exploration of coastal waters.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod, assisted by Roy G. Pearce, A. C. Redfield, N. B. Taylor, and J. M. D. Olmsted, and by others. Sixth edition. Pp. xxxii+1074+9 plates. (London: Henry Kimpton, 1930.) 42*s.* net.

Prof. Macleod's text-book is now well established in the literature, in fact, it has reached its sixth edition in the course of twice as many years. It blends under one cover general and special physiology and biochemistry and applied or clinical physiology: it is larger than works devoted to clinical physiology, but makes no attempt to deal in any detailed manner with many of the problems of specialised physiology. In fact, this science has now so many branches, general, biochemical, and histological, that it has become impossible for one volume to deal adequately with all. Prof. Macleod has performed the useful service of selecting from the mass of literature material suitable for welding into a whole as human physiology, which is almost the same as clinical medicine, when healthy, and not diseased, individuals are the subject of study.

This edition has been thoroughly revised and in places rewritten: but in comparison with the total bulk of our knowledge, certain recent discoveries, which have loomed large in the public eye, assume their more correct proportions. The general plan of the work is well known: it is divided into ten parts devoted to the physico-chemical basis of physiological processes, the blood and lymph, the neuromuscular system, the special senses, circulation, respiration, digestion, excretion, metabolism, and the endocrine organs. It should be in the hands of all medical students and teachers of physiology and can be read with profit by all interested in the scientific basis of modern medicine.

Engineering Electricity. By Prof. Ralph G. Hudson. Second edition. Pp. viii+214. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1928.) 12*s.* 6*d.* net.

This book is intended primarily for the junior and senior engineering students of the Massachusetts Institute of Technology who are not specialising in electrical engineering. It contains an outline of lectures previously given by the author. These lectures are now discontinued, and in their place nine pages of the text are assigned each week for home study. The class-room exercises consist of three 'recitations' and one problem section per week. An independent laboratory course covers the same ground and follows the class exercises. The keynote of the work we are told in the preface is brevity, and since the students are nearing the end of their college studies the statements are made as rigorous as possible. Chap. xvii. is devoted exclusively to illustrations illustrating all kinds of electrical apparatus.

Apparently 'weatherproof' insulation and 'slow-burning' insulation are distinguished by the intensity of the shading. In Chap. xviii. a hundred practical problems are given. As a class-book we think this book will be useful. But considering its size we think that 12*s.* 6*d.* is far too much to charge for it.

Disease and the Man. By Prof. George Draper. (The Anglo-French Library of Medical and Biological Science.) Pp. xix+270+19 plates. (London: Kegan Paul and Co., Ltd., 1929.) 12*s.* 6*d.* net.

Dr. Draper provides us with a very interesting sidelight on the relation between disease and the type, physical and mental, of the patient. This book forms a useful extension to disease of the work of Kretschmer on the relation of bodily type to character. Anthropometric data are all too little used in connexion with disease. The author presents series of cases of gastric ulcer, gall-bladder disease, pernicious anæmia, tuberculosis and nephritis, and points out the varying physical characteristics which are common to these disease groups. The relation between psychological characters and physical disease is also considered.

The Planktonic Diatoms of Northern Seas. By Dr. Marie V. Lebour. (The Ray Society Volume 116 for the Year 1929.) Pp. x+244+4 plates. (London: Dulau and Co., Ltd., 1920.) 12*s.* 6*d.*

This book is indispensable to all biologists interested in the life of the ocean. The families, genera, and species are clearly defined and well illustrated, their distribution properly recorded. There is a good bibliography. An introductory chapter gives a brief account of the general morphology, reproduction, and nutrition. We learn that all diatoms without chromatophores are saprophytic. Some have fungi and other algæ as parasites, while a dinoflagellate is found on *Chaetoceros*. There are several symbionts, especially flagellates, while some diatoms have special associations with infusorians.

Letters to the Editor.

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

Constitution of Molybdenum.

FOLLOWING the successful analysis of chromium announced in NATURE of Aug. 9, I have now been able to apply similar methods to molybdenum. The mass-spectrum of this element is a remarkable one, and the credit of its discovery rests with Dr. A. v. Grosse, who prepared the specimen of molybdenum carbonyl with which the work was done.

In contrast to the theoretical prediction of Russell (NATURE, Oct. 20, 1923) molybdenum has no less than seven isotopes, and the group indicates relative abundance relations far closer than those of any other multiple element so far investigated. Owing to incidental difficulties, which I need not enumerate here, measurements could not be made so accurately as usual. The following are the mass numbers and their approximate percentage abundance :

92	94	95	96	97	98	100
14·2	10·0	15·5	17·8	9·6	23·0	9.8

By comparison with the doubly charged mercury group the packing fractions of Mo^{98} and Mo^{100} were provisionally estimated. Both appear to be about $-5·5$, a considerably smaller negative value than that expected from the curve. From these values, correcting to the chemical scale we get :

$$\text{Atomic weight of Mo} = 95·97 \pm 0·05$$

in good agreement with the figure 96·0 obtained by chemical methods.

Two of the isotopes are isobaric with the well-established isotopes of zirconium 92 and 94, and a third with the doubtful one 96.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Aug. 21.

The Period of 'Actino-uranium' and its Bearing on the Ages of Radioactive Minerals.

FROM the mass-spectrum of the mixture of lead isotopes isolated from Norwegian bröggerite Dr. F. W. Aston (NATURE, Mar. 2, 1929, p. 313) estimated the relative proportions of the individual isotopes to be approximately

Pb^{206}	Pb^{207}	Pb^{208}
86·8	9·3	3·9

The line 207 is referred to the end-product of the actinium series, and the latter is regarded as having its origin in an isotope of uranium (*actino-uranium*). In the course of a discussion of the significance of Aston's results, Sir Ernest Rutherford tentatively estimated the half-value period of the hypothetical isotope (NATURE, Mar. 2, p. 314 ; 1929). Taking the period of uranium I as $4·5 \times 10^9$ years, he found a probable value of $4·2 \times 10^8$ years for the period of actino-uranium. If this estimate (based on the unexpectedly high amount of Pb^{207} found by Aston in the bröggerite lead) be of the right order, then it follows that Pb^{207} has been generated in minerals more rapidly from the actinium series than Pb^{206} from the uranium series. In calculating the ages of radioactive minerals it would therefore be necessary to allow for this difference. The object of this letter is to direct attention to another line of evidence from which it can be inferred that the periods of uranium I and actino-uranium are probably more nearly equal, and that no correction to the calculated ages of minerals is required in the present state of our knowledge.

From the approximate constancy of the ratio of actinium or protoactinium to uranium in minerals, it has generally been accepted that the percentages of atoms disintegrating via actinium and radium respectively are about 3 and 97. This ratio has recently been investigated afresh by J. E. Wildish (*Jour. Am. Chem. Soc.*, **52**, Jan., 1930, p. 163), who finds that the number of atoms of protoactinium disintegrating per 100 atoms of uranium I ranges in five different minerals from 1·47 to 5·16. Incidentally, this departure from constancy strengthens the growing belief that the actinium series is not a branch of the uranium series ; it also raises a doubt whether the actinium parent can be an isotope of uranium. The immediate point of importance, however, assuming that actinium produces Pb^{207}, is that the number of atoms of Pb^{207} produced in radioactive minerals at the present time is 3 ± 2 for every 100 atoms of Pb^{206} produced from uranium I. If both uranium I and actino-uranium disintegrate at about equal rates, then in Pre-Cambrian minerals the percentage of accumulated Pb^{207} to accumulated Pb^{206} should also fall within this range. If, on the other hand, Rutherford's suggestion is true, that actino-uranium disintegrates more rapidly than uranium I, then the proportion of accumulated Pb^{207} should be definitely higher. For a few minerals data are available which permit a test of these alternatives.

Let A = atomic weight of the mixture of lead isotopes isolated from a mineral ;

$$\left.\begin{aligned} a &= \text{percentage of } Pb^{207} \\ b &= \text{percentage of } Pb^{206} \\ c &= \text{percentage of } Pb^{208} \end{aligned}\right\} \text{in the mixture of lead isotopes.}$$

Then we have

$$207a + 206b + 208c = 100A$$
$$a + b + c = 100$$
$$\frac{a+b}{c} = \frac{U}{0·38\ Th}$$

where U and Th represent the respective percentages of uranium and thorium in the mineral. The third equation is based on the fact that the lead-producing capacity of thorium is only 0·38 times that of uranium which, as chemically determined, includes actino-uranium as well as uranium I.

From the three equations we find

$$c = \frac{100}{\left(\frac{U}{0·38\ Th} + 1\right)}$$

and

$$a = 100(A - 206) - \frac{200}{\left(\frac{U}{0·38\ Th} + 1\right)}$$

The packing-effect is clearly important here, for if the atomic weight of Pb^{206} be 206·016 (as suggested by Aston), then the value of a will be diminished by 1·6, which is a considerable part of its total value. In the following table a is therefore calculated from the expression

$$a = 100(A - 206·016) - \frac{200}{\left(\frac{U}{0·38\ Th} + 1\right)}$$

	I.	II.	III.	IV.
A = At. Wt. of Pb	206·048	206·046	206·071	206·122
U per cent	c. 72	73·07	66·88	65·28
Th per cent	0·00	0·28	1·89	6·86
$\frac{U}{0·38\ Th}$	∞	686·75	93·12	25·04
a (Pb^{207})	3·20	2·71	2·38	2·92
b (Pb^{206})	96·80	97·14	96·56	93·24
c (Pb^{208})	0·00	0·15	1·06	3·84
$\frac{100\,a}{b}$	**3·3**	**2·8**	**2·5**	**3·1**

I.—Pitchblende, Katanga, Belgian Congo. Analyses, See G. Kirsch: "Geologie und Radioaktivität", p. 171, 1928; At. Wt., Hönigschmid and Birckenbach: *Ber. Deutsch. Chem. Gesell.*, Berlin, p. 1837, 1923.
II.—Uraninite, Morogoro, Tanganyika Territory. Analyses, See G. Kirsch: *op. cit.*, p. 170; At. Wt., Hönigschmid and Horovitz: *Monatsheft f. Chem.*, **36**, p. 355, 1915.
III.—Uraninite, Black Hills, South Dakota, U.S.A. Analyses, Davis: *Am. Jour. Sci.* (5), **11**, p. 201, 1926; At. Wt., Richards and Hall: *Jour. Am. Chem. Soc.*, **48**, p. 704, 1926.
IV.—Bröggerite, Raade, Moss district, S.E. Norway. Analyses, Gleditsch: *Norsk. Videns Akad.*, Oslo, I Mat. Nat. Kl., No. 3, 1925; At. Wt., Richards and Wadsworth: *Jour. Am. Chem. Soc.*, **38**, p. 2613, 1916.

In addition to the minerals listed there are some others of Pre-Cambrian age for which analytical and atomic weight data have been recorded. For the lead from the uraninite of Sinyaya Pala, East Karelia, Nenadkevitch gives two atomic weight determinations, 206·02 and 206·11 (*Min. Abstracts*, London, **3**, p. 263; 1927). On these results, $100a/b$ is between 0·2 and 10 with an average of 5. The cleveites of the Arendal district investigated by Mlle. Gleditsh (*op. cit.*) give very low or very high results for a, probably because the minerals are altered, in which case the method of calculation is invalid. Similarly, the thorium minerals of Ceylon are unsuitable as a test. They, too, are altered, and for each of them a turns out to be negative. So far as I am aware, only the four minerals given in the table can be appealed to safely for a solution of the problem under discussion.

The ratio $100a/b$, which is the ratio of accumulated Pb^{207} to accumulated Pb^{206}, is thus found to vary between 2·5 and 3·3. This clearly means that through the greater part of geological time the proportion of Pb^{207} generated in minerals has been of the same order as that generated at the present time. The adoption of a smaller value for the factor here taken as 0·38 (Kirsch favours a value near 0·25) leads to the same conclusion. There is certainly no indication that Pb^{207} was produced more rapidly 10^9 years ago than it is now, and we may therefore conclude:

1. That Aston's estimate of 9·3 per cent for the Pb^{207} in Norwegian bröggerite is too high to be considered representative;
2. That Rutherford's resulting estimate for the period of actino-uranium is too low;
3. That the periods of both uranium I and actino-uranium are probably of the same order; and
4. That in consequence there is at present no necessity to make any correction for the actinium series in age calculations when uranium has been determined chemically.

ARTHUR HOLMES.

The University, Durham,
July 28.

Catalysis.

IT is well known that only a few of the collisions between reacting molecules result in a reaction taking place, a certain 'energy of activation' being necessary to make the collision effective. The reducing factor for the case of three degrees of freedom is Exp. $(-E/RT)$ where E is the energy of activation. The value of E appears to be of the order of some tens of thousands, say, 50,000 calories per molecule. For a reaction at 1000° Abs., the index is of the order of -24.

Any cause which reduces the degrees of freedom by unity would reduce this index by one-third part; a reduction of two degrees of freedom would reduce it by two-thirds of its value and if all degrees of freedom were removed the index would disappear entirely. With the above value of E, the exponential factor in the several cases becomes (1) $3·77 \times 10^{-11}$ (2) $1·12 \times 10^{-7}$, (3) 3×10^{-4} and (4) unity, the first being the value met with in normal gas reactions.

Now an adsorbed layer of oriented polar molecules with their proper poles all pointing outwards toward a surrounding gas will tend to swing the colliding molecules round so that instead of it being a question of chance, it may become a certainty that the suitable poles for reaction to take place will be presented to one another; in this case, the rate of reaction passes from the first to the second of the above categories and it is therefore increased in a ratio of about 30,000 and we have a reasonable case of catalytic acceleration. If, further, the forces experienced by an oncoming molecule could swing it round the axis of approach so that it inevitably 'fits' its future partner, a second degree of freedom passes into the category of certainties and we have case (3) and the catalytic activity is multiplied by 10^9; and so on.

On the other hand, catalytic 'poisoning' occurs when the wrong poles are made inevitably to present themselves. A single layer might be quite effective in stopping a reaction; and a *very much smaller* quantity might reduce the rate a few hundred or thousand times, and this, in commercial practice, is equivalent to stopping it altogether.

It is quite commonly supposed that the facts of catalysis require a reduction in the value of E, whereas the above considerations show that E may remain of its normal value. To point this out is the main object of this letter. There is still considerable mystery enshrouding E. It is taken to be energy which a molecule must acquire before it can be in a reactive state; on the other hand, in the formula, it is calculated from the energy of molecular agitation. The need for a minimum velocity of agitation becomes clearer if we think of the corresponding case of expulsion of electrons by colliding α-particles: only particles of certain minimum velocities can penetrate the atoms to the requisite levels. Something of the same kind may be conceived as taking place in atomic interchange. If so, it is unlikely that the quantity E should change and considerations such as that taken into account in this communication become all-important.

ALFRED W. PORTER.

The Electrical Properties of Active Nitrogen.

WE have recently been investigating the electrical conditions obtaining in active nitrogen, and our findings seem of sufficient interest to justify a preliminary note thereupon. They are as follows:

(1) Removal of all charged bodies from a stream of active nitrogen is without effect upon its chemical properties, or the concentration of the chemically active species. Lord Rayleigh has already found that complete removal of ions from the glowing gas does not diminish its luminosity or its ability to develop spectra of other substances, but no examination has hitherto been made of any possible effects upon the

chemical activity. This result is in accordance with expectations.

(2) Constantinides has already found that the current which passes between two electrodes of different areas bathed in the afterglow is proportional to the area of the *cathode*, and has therefore concluded that the conductivity of active nitrogen is due to emission of electrons by the metal, either photoelectrically or else under bombardment by the luminous gas. We find that if the electrodes are placed in a thin quartz vessel surrounded by, but not actually containing, glowing nitrogen, no current passes, even under the most varied conditions of experiment both in the electrode chamber and outside. We therefore conclude either that the effect is produced by light of a wave-length less than 1400 A., or that the second of Constantinides' theories is correct, and that it may be regarded as evidence for the presence of a metastable form of nitrogen which is deactivated by the metal surfaces, with emission of electrons, as in the experiments of Oliphant upon metastable atoms of helium. When the electrodes are immersed in the glowing gas, the current depends upon the area of the cathode, as found by Constantinides, but also upon the metal of which it is composed. Attempts are being made to correlate it with the work-function of the metal; such estimates as we have been able to obtain suggest something greater than 4 volts as the minimum energy of the metastable body causing the emission of electrons.

(3) When the glow is destroyed by heating the gas before it reaches the electrodes, the conductivity also vanishes, but the concentration of chemically active nitrogen remains unchanged, as already found by one of us (E. J. B. W.); the observation seems to indicate that another modification of nitrogen is present which is chemically inactive, but able to cause metals to emit electrons, and possesses an energy of not less than about 4 volts. It may be noted that the Cario-Kaplan theory provides for the existence of metastable molecules of *c.* 8 volts, the destruction of the glow by heat being due on the same theory to the deactivation of these molecules on hot surfaces.

(4) We have been able to correlate the observed conductivity and glow intensity with the nature and concentration of the photogens, or other gases, present in active nitrogen.

E. J. B. WILLEY.
W. A. STRINGFELLOW.

Chemistry Department,
University College, W.C.1,
July 23.

Raman Displacements and the Infra-red Absorption Bands of Carbon Disulphide.

THE Raman spectrum of carbon disulphide has been determined by a number of observers (Gavesan and Venkateswaran, NATURE, **124**, 57; 1929; Petrikaln and Hochberg, *Zeit. phys. Chem.*, B. **3**, 217; 1929; and by Schaefer, Matossi, and Anderhold, *Phys. Zeit.*, **30**, 584; 1929). In all cases an intense line displaced by 654-658 cm.$^{-1}$ was observed, together with a weak line corresponding to 795-807 cm.$^{-1}$. The spectrum is of considerable interest, as it has been impossible up to the present to reconcile it with the observed infra-red spectrum as determined by Coblentz.

We have recently reinvestigated the absorption spectrum, using the vapour of carbon disulphide, and have explored the region from 1μ to 22μ. In this range there are four bands, *A*, *B*, *C*, and *D* at 878, 1522, 2179, and 2335 cm.$^{-1}$ respectively; of these, owing to its great intensity, *B* is probably a fundamental band, ν_3. Now it has been previously assumed (Ghosh and Mahanti, NATURE, **124**, 230; 1929; and *Phys. Zeit.*, **30**, 531; 1929; Snow, *Proc. Royal Soc.*, A **128**, 311; 1930) that the two Raman lines are in effect a doublet of the same nature as is given by carbon dioxide, and that this type of Raman spectrum is characteristic of such linear molecules: on this supposition Ghosh and Mahanti have averaged the frequencies of the two Raman lines and attempted to deduce the infra-red spectrum with this value as a fundamental. Nitrous oxide gives only one line, however, and we believe that the two lines for carbon disulphide have different origins. We postulate two additional fundamental frequencies, $\nu_2 = 655$ cm.$^{-1}$ (optically inactive), and $\nu_1 = 150$ cm.$^{-1}$ approximately. The spectra can now be summarised as in the table below. All frequencies are in wave numbers.

THE ABSORPTION SPECTRUM OF CARBON DISULPHIDE VAPOUR IN THE INFRA-RED.

Infra-red Band.	Raman Line.	Origin.	Calculated Value.
(150)	—	ν_1	—
—	655	ν_2	—
—	800	$\nu_1+\nu_2$	805
878	—	$\nu_3-\nu_2$	867
1522	—	ν_3	—
2179	—	$\nu_3+\nu_2$	2177
2335	—	$\nu_3+\nu_2+\nu_1$	2322

Some bands isolated by Coblentz seem to be characteristic of the liquid state as they are absent from our spectrum.

We would add that we have resolved with certainty two of these bands into *P* and *R* branches with a frequency difference of 12-13 cm.$^{-1}$. Carbon disulphide, then, is a rectilinear molecule with one moment of inertia, the value of which is approximately 312×10^{-40} gm. cm.^{2}

C. R. BAILEY
A. B. D. CASSIE.

Sir William Ramsay Laboratories of
Inorganic and Physical Chemistry,
University College, London,
Aug. 5.

Absorption of Sound at Oblique Incidence.

IN the issue of NATURE for July 5 Dr. E. T. Paris discusses some recently published work at the Bureau of Standards on the absorption of sound at oblique angles of incidence. A detailed discussion of Dr. Paris's criticism of our experimental technique does not seem called for at present. These experiments are pioneer work on this subject, and it is much to be desired that others should give the question experimental attention, the more so because the Bureau's results are at variance with previous theoretical conclusions.

Paris (*Proc. Roy. Soc.*, A, **115**, p. 407; 1927) and Larmor (*Proc. Camb. Phil. Soc.*, **27**, part 2, p. 231; April 1930) have investigated the subject mathematically, and have reached conclusions which fail to agree, not only with the Bureau of Standards' results, but also with each other. For grazing incidence, Larmor finds that the absorption should be infinite, while Paris comes to the conclusion that it should be zero.

It would be very desirable that the reasons for this discrepancy in the two theories should be cleared up. It is possible that there is a fundamental inconsistency in the assumption of potential flow and absorption at reflection. This is pointed out in the Bureau of Standards' publication (Bureau of Standards *Journal of Research*, Feb. 1930). Sound absorption depends upon friction in capillary channels, and must lead to rotational motion, not only in the absorbing material but also throughout a thin layer close to the surface; and in the presence of rotational motion there can exist no velocity potential.

As a similar phenomenon, the Prandtl boundary layer in aerodynamics may be cited. Although at some distance from an airfoil the motion of the air is well represented by potential theory, yet in the immediate neighbourhood of the surface the potential theory fails to give even a rough approximation to the actual motion. It is to the failure of the fluid to maintain irrotational (potential) flow in the neighbourhood of the surface that the whole lift and drag of an airfoil is to be ascribed.

It seems probable that an adequate theory of sound absorption must contain as an essential part a thin layer of air in rotational motion.

Paul R. Heyl
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Bureau of Standards,
Washington, D.C.

Influence of Nitrogen Dioxide upon the Ignition Temperature of Hydrogen-Oxygen Mixtures.

Mr. H. J. Schumacher has proposed (Nature, July 26, p. 132) an explanation of the explosive action of nitrogen dioxide in hydrogen – oxygen mixtures at temperatures in the neighbourhood of 380° C. The ignition occurs according to Thompson and Hinshelwood between sharply defined limiting pressures of nitrogen dioxide. Schumacher's explanation is based upon the assumed competition of the following two reactions :

(1.) $NO_2 + O = NO + O_2 (+51 \text{ cal.})$
(2.) $H_2 + O = OH + H (+8 \text{ cal.})$

It is assumed that the oxygen atoms are produced from nitrogen by collisions with 'hot' molecules. Photochemical production of even greater numbers of oxygen atoms [1] than could originate in this way has been found unable to cause explosions at temperatures at which nitrogen dioxide in the correct concentrations is effective. On the other hand, the formation of water in the region immediately outside both limiting concentrations falls to negligible values, in contradiction to that which would be expected from the mechanisms (1) and (2).

The whole phenomenon is to be attributed to a process occurring at the wall of the reaction chamber [2] where the so-called non-stationary explosions are stimulated by very small quantities of nitrogen dioxide added to the gas and hindered by greater additions which poison the surface.

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July 31.

[1] *Die Naturwissenschaften*, p. 266, 1930, and p. 443, 1930; also Vortrag: Bunsen Tagung, Mai, Heidelberg, to appear shortly in *Zeitschrift für Elektrochemie*.
[2] H. N. Alyea und F. Haber, *Die Naturwissenschaften*, p. 441, 1930.

Boscovich and Theories of Light.

In histories of science full justice is done to the perspicacity of Newton in suggesting a compromise between the corpuscular and undulatory theories of light. According to Mr. Dampier-Whetham, "the most striking feature about Newton's theory is its resemblance to quite modern conceptions". Speaking elsewhere of recent views about light, he refers to one which postulates "a complex of particles and waves which recalls even more vividly Newton's ideas".

No mention, however, is made of the efforts of Boscovich to give a working hypothesis which would combine the good points of both conceptions. In Mr. Dampier-Whetham's book "A History of Science" Boscovich is mentioned only in connexion with his theory of matter and then the name is spelled Boscovitch. In his "Philosophiæ Naturalis Theoria" (my copy is dated Vienna, 1759, therefore one year after the first edition) Boscovich certainly sums up in favour of a corpuscular theory and "contra omnes alias hypotheses, ut contra undas, per quas olim phænomena lucis explicare conatus est Hugenius". But he is aware of the strong points of the wave theory and suggests that the light particle has an oscillatory movement. Doubtless the idea is crude and is founded chiefly on the assumption of unequal initial velocities of the components of each particle when expelled from the light source; but it was considered sufficiently important to be noticed by Thomas Young.

W. A. Osborne.
University of Melbourne,
June 26.

The extract from the writings of Boscovich which Prof. Osborne quotes is interesting. Until the reason for the rectilinear propagation of light-waves was explained by the work of Young and Fresnel on interference, the difficulties of an undulatory theory were very great, and it is not surprising that Boscovich, like Newton, "sums up in favour of a corpuscular theory". His attempt to combine with it some of the advantages of a wave theory as described by Prof. Osborne seems to me less successful than the method adopted by Newton.

C. Dampier-Whetham.

Curling.

In Nature of Mar. 15 there appeared a letter by W. H. Macaulay and Brig.-General G. E. Smith in which a theoretical treatment of curling was given. The results or conclusions were so nonconcordant with the known behaviour of curling stones that the authors ended their letter by raising a question as to what important feature of the motion had been overlooked.

As it is obvious that the writers were unaware of the experimental study of this problem made by myself, may I direct attention to the report on this work which was published in the *Transactions of the Royal Society of Canada*, Vol. 18, p. 247; 1924. The experimental work involved not only observing the motion of curling stones on standard ice sheets such as are regularly employed in curling, but also a study of torques transmitted to curling stones by a motor-driven rotating ice sheet. The results definitely pointed to the conclusion that the explanation of the curvature of the path taken by a stone possessing both translational and rotational velocities was to be found neither in the suggestion of Sir Gilbert Walker that the friction was greater on the rear edge of the cup nor in any differential air pressure effects as others have suggested, but rather hinges on the very rapid increase in the ice-stone friction as the velocity of the stone with respect to the ice becomes low and approaches zero. This means that the edge of the cup on which the tangential velocity due to the rotation is in a direction opposite to the direction of the translational velocity of the stone, that is, the slow edge of the cup, will experience a greater friction than the diametrically opposite portion of the rim. The difference between the two forces—in other words the asymmetry of the retarding forces—and the resulting curvature in the path taken therefore depend not only on the 'speed' and the 'spin' given the stone, but also on the ice conditions, just as is observed in practice.

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Holes produced in Ground by Lightning Flash.

DURING a thunderstorm of considerable severity which passed over a district near Rothbury, Northumberland, on the afternoon of Tuesday, Aug. 12 last, a flash of lightning apparently struck the ground and produced in it a vertical hole, approximately circular in section, and found on measurement to be 1 ft. 11 in. in depth. The hole is tapered, being 6 or 7 in. in diameter at the surface and about 2 in. in diameter at a distance of a foot below the surface. The hole was made in a grass field which lies on sloping ground and which consists of light loamy soil. The field, about 17 acres in extent, is almost surrounded by trees (chiefly firs). The position of the hole is not at the highest part of the field, but several feet below the highest level, while beyond the field are hills and moorland rising to a height of some hundreds of feet above the field. In the field is a clump of fir trees, close to which is a small hut, distant from the hole about 60 yards. A gamekeeper who was in the hut at the time the flash occurred was thrown violently backwards by the concussion which followed the flash, although he is confident he did not experience any electric shock. A hen in a coop about 10 ft. from the hole was killed, as also were four young pheasants, one inside the coop, and three near, but outside, it. A heavy rain accompanied the storm, which might account for the absence of any sign of burning round the hole. There were also two smaller holes formed at distances respectively of 4 ft. 6 in. and 7 ft. 6 in. from the main hole. The first was nearly horizontal, was open on the surface for some 10 in., and, for the few inches where it penetrated the surface, was about half an inch in diameter. The second was smaller still, slightly inclined to the vertical, and approximately a quarter of an inch in diameter and some two or three inches deep.

Apart from the well-known phenomenon of 'fulgurites', it would be interesting to learn if effects similar to those above described are familiar to meteorologists.

WILFRED HALL.

Hepple, Northumberland,
Aug. 26.

Adsorption of Hydrogen and Carbon Monoxide on Oxide Catalysts.

IN the course of experiments on the heats of adsorption of hydrogen and carbon monoxide on oxide catalysts, it was observed that these gases behaved in a curious manner on desorption. Hydrogen or carbon monoxide adsorbed at room temperature on the $ZnO - Cr_2O_3$ catalysts at equilibrium pressures of 10^{-3}-10^{-4} cm. was evolved on raising the temperature to 100°-120°, but within a period of 20-30 minutes, it was readsorbed on the surface giving a hard vacuum in the containing vessel. On further raising the temperature, no gas was evolved until 350° C., when water vapour or carbon dioxide respectively was liberated. Mixtures of hydrogen and carbon monoxide behaved similarly, being evolved and readsorbed at 100°-120° C. and finally at 350° C. being converted into a mixture of water and carbon dioxide, no appreciable quantities of organic compounds being formed.

Hydrogen on copper oxide gives similar phenomena, as was shown by Mr. M. H. Hall.

Hydrogen or carbon monoxide is thus adsorbed on oxide surfaces in two distinct ways, one occurring at room temperatures, the process being reversible, and the other occurring at higher temperatures, which is irreversible. The reduction of oxides by either hydrogen or carbon monoxide therefore occurs in three stages, (1) the physical adsorption of hydrogen, (2) the chemical combination with the surface atoms, and (3) the desorption of water or carbon dioxide. It is curious that the physically-adsorbed gas must leave the surface before it can enter into chemical combination with the metallic oxides.

W. E. GARNER.
F. E. T. KINGMAN.

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Capture of Electrons by α-Particles.

EXPERIMENTS, similar to those of Davis and Barnes (*Phys. Rev.*, **34**, 152, 1929; **35**, 217, 1930), have been made, in which a beam of α-particles passed through a stream of electrons, moving parallel to the α-particles. The apparatus differed from that of Davis and Barnes chiefly in that a Geiger counter, with mechanical recording system, was used in place of a scintillation screen, and that the polonium was inside the evacuated vessel. The number of singly-charged particles was always about one per cent of the total. The numbers of both doubly- and singly-charged particles were found to be entirely unaffected by the electron stream throughout the voltage range investigated, namely, from 450 to 750 volts. In particular, no capture was observed when the velocities of α-particles and electrons were nearly equal. Capture by the doubly-charged particles to an extent of less than 0·5 per cent would probably not have been detected, on account of probability error. N. A. de Bruyne was associated with me during part of this work.

H. C. WEBSTER.

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Cambridge.

Palæolithic Man in North-East Ireland.

THE series of Late Glacial and post-Glacial deposits reported upon by Dr. R. Lloyd Praeger from the Lagan estuary at Belfast [1] has been described as the most complete stratigraphical record of the post-Glacial sequence in the British Isles. The basal reassorted boulder clay was here overlain by grey sand with cold fauna, an early peat yielding *Cervus megaceros*, and superimposed estuarine clays, the lower of which has been elsewhere shown to have preceded the deposition of the well-known 25 ft. raised beach. We have recently found in such lower estuarine clay, in the neighbourhood of Larne, a derived but well-developed Magdalenian industry in flint. This industry will also be described by Mr. Burchell in his presidential address to the Prehistoric Society of East Anglia for 1931.

J. P. T. BURCHELL.
C. BLAKE WHELAN.

[1] Praeger, "On the Estuarine Clays at the new Alexandra Dock, Belfast": *Proc. Belfast Nat. Field Club*, series 2, vol. 2, Appendix for 1886–87, pp. 29-52, 1887.

Science and Industry in Bristol.

By Engr. Capt. EDGAR C. SMITH, O.B.E., R.N.

NINETY-FOUR years ago the British Association, then but six years old, visited Bristol. After holding its first gathering at York in 1831, it had met at Oxford, Cambridge, Edinburgh, and Dublin, and then breaking away from the universities it came to a city the history of which is bound up with shipping, manufacture, and trade. Bristol to-day possesses its own university, with buildings which in beauty and dignity rival any to be found elsewhere, yet its geographical position and the energy and enterprise of its citizens have made it one of our chief commercial centres, and such it will probably remain. "The story of the trade of Bristol for a thousand years", said Mr. Baldwin when Prime Minister, "is the story of the trade of England", and at the recent summer meeting of the Institution of Mechanical Engineers the Lord Mayor and others referred with pride to Bristol's multiplicity of manufactures, volume of shipping, fine docks, air port, and municipal activities.

From very early times Bristol was a town of importance and a trading centre. When London had but 35,000 inhabitants, Bristol numbered 9000, and to-day it boasts of a population of some 400,000, the great majority of whom are connected with factories, warehouses, docks, and shipping. Declared by an early writer as a port fit and safe for a thousand ships, for the Siege of Calais Bristol provided Edward III. with 24 ships and 600 seamen; its Merchant Venturers stimulated both overseas commerce and exploration, and the noble memorial tower to the Cabots, erected in 1897, is a reminder of the famous voyage of the Bristol ship *Matthew*, which left the port on May 10, 1497, carrying the first Englishmen who ever saw the coast of North America.

If Bristol is a city concerned mainly with grain, fruit, sugar, chocolate, oil, and tobacco, with markets and commodities, it is nevertheless a city abounding in ecclesiastical, archæological, literary, and scientific associations. Few there are who go to Bristol who fail to visit St. Mary Redcliff, described by Leland as "by far the fairest of all churches", or recall the sad story of the unhappy poet Chatterton, whose boyhood was passed beneath its shadow. It was his strange work which brought Johnson and Boswell to Bristol, and led Johnson to remark, "This is the most extraordinary young man that has encountered my knowledge. It is wonderful how the whelp has written such things."

Scarcely less remarkable for his early achievements, but more fortunate in his environment than the Bristol attorney's apprentice, was the surgeon's apprentice from Penzance, Humphry Davy, who, still under the age of twenty, came to Bristol in 1798 to take charge of the laboratory at the Pneumatic Institution of Dr. Beddoes. A student of medicine in London and Edinburgh and sometime reader in chemistry at Oxford, Beddoes thought that the study of the physiological effects of different gases might have important therapeutic applications, and with this in view opened his hospital at Bristol. Known already to the Wedgwoods, to Gregory Watt, and to Davies Gilbert, through Gilbert, Davy joined Beddoes, and on Oct. 2, 1798, began work in the laboratory. If to the Bristol period of Davy's brilliant career belongs the publication of hastily conceived theories and ill-supported conclusions, to it also belongs the discovery of the effect on human beings of nitrous oxide. "A young man, a Mr. Davy, at Dr. Beddoes'," wrote Maria Edgeworth, "who has applied himself much to chemistry, has made some discoveries of importance, and enthusiastically expects wonders will be performed by the use of certain gases which inebriate in the most delightful manner, having the oblivious effects of Lethe, and at the same time giving the rapturous sensations of the Nectar of the Gods!"

At the time Davy was with Beddoes, and when he began his friendships with the Edgeworths and with Southey and Coleridge, the only means of reaching Bristol was by boat or horse or coach, and it was by these means that the members of the British Association came to the meeting of 1836, presided over by the Marquess of Lansdowne. From the north came Brewster, father of the Association, and J. D. Forbes; from Cambridge came Whewell; from London, Babbage, Wheatstone, Lardner, and Roget; and from Plymouth, Snow Harris. Brewster had spent a week with Fox Talbot at Lacock Abbey—"a paradise: a fine old abbey with the square of cloisters entire, fitted up as a residence, and its walls covered with ivy and ornamented with the finest evergreens"—now known to every student of the early history of photography. During the meeting Brewster stayed with "Mr. Daniells, Clifton", as also did the German geologist von Raumer. "The Bristol meeting went off extremely well", wrote J. D. Forbes from Edinburgh, to de la Rive, "and promises admirably for the permanency of the Association." For Forbes and his family, Bristol was to have other memories, for it was to the skill and attention of Dr. J. A. Symonds of Clifton he owed the prolongation of his life. To Symonds, whose house is now a hall of residence for women undergraduates, Forbes in after years sent the first copy of his *opus magnum*, his valuable historical review of the progress of physical science from 1775 to 1850, contained in the 8th edition of the "Encyclopædia Britannica". It was at Clifton, too, that Forbes on the last day of 1868 breathed his last.

If travellers in 1836 had still to submit to the discomforts of the mail coach, they were all acquainted with the progress of the new railways, and no visitor to Bristol could have failed to hear of Brunel, then engaged on the construction of the line from Bristol to London. Brunel with Locke and Robert Stephenson formed the triumvirate of the early railway world, and Brunel's finest monument is the Great Western Railway. A Bristol and London Railroad Company had been formed in the Bristol Guildhall on July 30, 1833, and two years later Brunel wrote: "I am thus engineer to the finest work in England. A handsome salary, on excellent terms with my directors, and all going smoothly." Opened as far as Maidenhead in 1838, the line was extended to Reading early in 1840, Bristol and Bath were joined in August of the same year, and Bristol and London in June 1841. When next the British Association met in Bristol no fewer than 17,000 miles of railroad had been laid down in the kingdom, and Brunel's bridges and viaducts were the admiration of the world.

Brunel's association with Bristol did not end, however, with the railway. The line from London to Bristol had given birth in his remarkable mind to the idea of a steamship to connect Bristol with New York, and on the banks of the Avon in 1836 was laid the keel of the most famous and most successful of all early trans-Atlantic liners. Designed by Brunel, built by Patterson, and engined by Maudslay of London, the *Great Western* was 236 ft. long, 2300 tons displacement, and 750 horse-power. She left Bristol on her maiden voyage, on April 8, 1838, crossed to New York in fifteen days, and before she was sold in 1846 she had crossed and recrossed 74 times. What George Stephenson's Liverpool and Manchester line of 1830 had been to the railway so the *Great Western* was to trans-Atlantic steam navigation. Neither must it be forgotten that Brunel's *Great Britain*, the first screw ship to cross the Atlantic, was also built at Bristol.

Just as the builders of railways had to fight opposition and disarm criticism, so the promoters of the Atlantic steamships had to face scepticism, and the British Association meeting of 1836 gained a certain notoriety through the public lecture of Lardner, then professor of natural philosophy and astronomy in University College, London, and the recognised and popular exponent of science. Lardner in his lecture saw fit to sound a note of caution regarding the scheme for trans-Atlantic steam navigation, but himself incautiously spoke of it as chimerical. The storm of protest which broke upon his head was more or less deserved, but the letters of Macgregor Laird and others were not half so effectual a reply as the fine performances of the *Great Western*.

Brunel had first become known in Bristol through his plans for a bridge to span the Avon at Clifton. His were not the only plans and Brunel did not live to see the bridge erected, but when in 1864 the fine suspension bridge was opened, incorporated with it were the chains from the old Hungerford footbridge over the Thames at London, built by Brunel in the 'forties, but which had had to make room for Hawkshaw's Charing Cross Bridge. The responsibility for the Clifton Bridge we see to-day was shared by Hawkshaw and Barlow, and it was Hawkshaw who in 1875 came to Bristol to preside over the British Association on the occasion of its second visit to the city.

By 1875 the British Association had become a great national institution, having long achieved that permanency Forbes hoped for, while the names of Huxley, Darwin, Tyndall, and Thomson were on everybody's lips. Serving many causes, it had especially promoted the spread of knowledge, and its second visit to Bristol took place just before the birth of the college which was founded in 1876 and from which has sprung the university which is to-day one of the glories of the city. With an ancient grammar school, and the newly founded Clifton College within its boundaries, Bristol in the early 'seventies was still without the means for higher instruction. But following the lead of London, Newcastle, Manchester, North Wales, and Leeds, and supported by Balliol and New College, Oxford, Bristol on June 11, 1874, at the Victoria Rooms, Clifton, launched the scheme for a college of university rank. Backed by the great influence of Jowett and of Percival, then headmaster of Clifton College, the scheme was further discussed at a meeting in August 1875, while the British Association was in session, and in 1876 the college began its work.

The first lectures of the college were given in a dilapidated old house in Park Row, at the top of Park Street; the first professor of chemistry was Letts; the first principal, the economist Alfred Marshall. The removal of Letts to Belfast and of Marshall to Cambridge opened the path for Ramsay, who at the age of thirty had already made his mark, and under him and his colleagues—Lloyd Morgan (who succeeded him as principal), Orme Masson, Sydney Young, Silvanus Thompson, Sollas, Hele Shaw, and others—the college soon attained to a leading position among the provincial centres of learning and research, and in 1909 it was raised to the dignity of a university. In St. Mary's Redcliff is a window to "the pious memory of men who made Bristol famous in the fourteenth and fifteenth centuries". No such memorial will be necessary for the men who have made Bristol famous in our own day: for their energy, enterprise, foresight, and munificence have already raised an enduring monument in the splendid range of university buildings, associated particularly with the name of the Wills family, which stands at the top of Park Street, where was once the house which sheltered its earliest professors and students.

The connexion of industry and science with Bristol might well be illustrated by references to many other men, places, and events. More than two hundred years ago, the famous Abraham Darby, before removing to Coalbrookdale, founded in Bristol the Baptist Mills Brass Works, where, with the aid of Dutch workmen, he endeavoured to meet a need of the times by casting iron pots in moulds of sand to take the place of the more expensive brass pots; while to Peregrine Phillips, Jr., a Bristol vinegar maker—of whom Sir Ernest Cook wrote in NATURE of Mar. 26, 1926, p. 419—we owe the invention of the contact process for the manufacture of sulphuric acid. Though the particulars of his invention are fully known, it is otherwise with the career of Phillips, details of whose life have escaped both the historians of chemistry and biographers. In our own time there have been few who have furthered the interests of science in

(*Continued on p.* 371.)

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Size and Form in Plants.

By Prof. F. O. Bower, F.R.S., President of the British Association.

Inaugural Address delivered at Bristol on Sept. 3.

TWO years have passed since the British Association last met in Britain. Events have happened in that interval which mark the close of the Darwinian epoch. Down House, in which Darwin lived and worked, has been bought, restored, and endowed by Mr. Buckston Browne and presented by him to the Association, which holds it in custody for the nation. The house is now open as a shrine to those who treasure Darwin's memory. They may enter the study where the "Origin of Species" was penned, or wander out to the Sand Walk, and draw such inspiration as those spots may yet afford to those who are face to face with problems cognate to his own. These years have also severed personal links with Darwin himself. Sir William Thiselton-Dyer, who died in December 1928, had been his frequent correspondent. It was he who, more than any other, carried the evolutionary stimulus forward into the botanical schools of Britain. Sir Edwin Ray Lankester, whose portrait by Orpen was a poignant feature of last year's Academy, died in August 1929. Not only was he the leading zoologist of his time, but he has left a deep impress on general morphology; for he was the first to analyse from the evolutionary aspect the degrees of 'sameness' of parts, whether in animals or in plants. These two octogenarians were among the latest links between Darwin himself and living men of science; so this last meeting of the Association before its centenary next year falls at a nodal point in the personal history of evolution.

Morphology, or the study of form, was closely interwoven with the life's work of Darwin, and—to use his own words—"it is one of the most interesting departments of natural history, and may almost be said to be its very soul". Since the Association has seen fit to choose as this year's president a botanist whose work has dealt specially with form in plants, the occasion seems apt for considering certain morphological questions that present themselves in this eighth decade since the "Origin of Species" was published.

The word 'morphology' was applied by Goethe in 1817, in a general sense, to the study of form. Though a pre-Darwinian, he showed rare foresight in insisting that the living form is only momentarily stable, never permanent. But years elapsed before that instability of form of living things, which he clearly saw, became the very focus of evolutionary theory. Even Goethe's prophetic gaze was blurred by the hazy imaginings of idealistic philosophy. The clarifying mind of Schleiden resolved that mist by resort to naked fact. In 1845 he stoutly asserted that the history of development is the true foundation for all insight into living form. This opened the way for a host of workers, who patiently observed and compared the facts of individual development, particularly in plants of low organisation. By them the field was prepared for the magic touch of Darwin; and, in the enthusiastic words of Sachs, "the theory of descent had only to accept what genetic morphology had actually brought to view".

The effect of that theory should have been to sweep aside all idealistic morphology based on the higher forms, and to rivet attention upon organisms low in the scale. It was the habit of starting comparison from the highest state of organisation that was the fundamental error of the idealistic

Nature-philosophers; even now traces of it still persist. An illuminating alternative was presented by that noble passage with which the "Origin of Species" ends. Speaking of his theory, Darwin wrote: "There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms, or into one; and that—from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved." He forecast from the application of his theory that "our classifications will come to be, as far as they can be so made, genealogies; and they will then truly give what may be called the plan of creation".

Whether there was only one original form of life or many is still an open question. Nevertheless, among the welter of organisms rightly held as primitive, the Flagellata may with some degree of reason be named as combining in their motile and sedentary stages respectively the animal and vegetable characters. They suggest a sort of starting-point from which the two kingdoms might have diverged. The probability of their common origin is strong; but the divergence must have been early, each taking its own independent course, with increasing size and complexity of the individual. In tracing this I would ask special attention to the kingdom of plants.

The first of the laws laid down by Lamarck in his "Histoire Naturelle" as fundamental in the evolution of animals and plants ran thus: "Life by its intrinsic forces tends to increase the volume of every living body, and to enlarge its parts up to a limit which it determines itself." When in unicellular organisms, following this law, a certain size has been reached, fission follows, and the equal halves separate as new individuals. In pluricellular bodies, however, the products of cell-division do not separate, but continue a communal life; and the individual may increase, with further division of its cells, to large size and complexity. We may picture how, based upon the mobile stage of a Flagellate, the aggregate might form an animal body with motility as a leading feature; on the other hand, based upon the sedentary stage, an immobile plant body would result. The animal, adopting a predatory habit and colourless, might progress along lines of dependent nutrition, finding and ingesting food already organised; the sedentary green plant might evolve along lines of physiological independence, constructing its own organic supplies. Whether or not this be a true picture, the whole organisation of the two kingdoms diverged on the basis of nutrition. Herbert Spencer contrasted them physiologically, showing how animals are expenders, while plants are accumulators; that the former are limited in their growth by the balance of expenditure against nutrition; in the latter, growth is not so limited. Thus the problems that follow on increasing size may be expected to work out differently in view of the animal kingdom comprising organisms of high expenditure and not self-nourishing, while plants are self-nourishing accumulators.

The result of this difference may be illustrated by contrasting some of the highest examples of either kingdom: for example, the elephant with the trees of the forest through which he roams; on one hand, the relative fewness of the mobile elephants, their less stature and compact form, their columnar legs needed to support the barrel-like body, the receptacle for ingested food, the economy of external surface and the highly developed internal surfaces; on the other hand, the height, immobility, and large number of the trees, with their massive stems and highly complex shoots and roots, so necessary for acquiring food directly from the air and soil. We may further contrast the genesis of the individual in either case. In the mammal the parts are formed once for all, its embryology being an incident closed early in the individual life; but in the tree, embryology may be continued for centuries, and is theoretically unlimited, except by death; during life it has the power of producing leaves and branches from every distal bud. The fact is that, though certain underlying principles are the same for both kingdoms, the working out has been distinct from the first. Hence the morphology of plants must stand on its own feet; indeed, it has been said with some degree of truth that whenever botanists have borrowed their morphological outlook from the sister science they have gone wrong.

The normal development of a multicellular plant starts from the fertilised egg, and elaboration both external and internal follows on increasing size. Polarity, that is the distinction of apex and base, is defined in most plants of high organisation by the first cell-cleavage. The apex adopts at once the continued development that is its characteristic. Branching of various types follows in all but the simplest, to constitute the complex shoot, while correlative basal branching gives the root-system that fixes the non-motile body in the soil. The scheme of growth and branching thus started is theoretically open to unlimited increase, and the initiation of new parts is in point of number on a geometrical scale. This is suitable enough for organisms able to accumulate material, as plants do; indeed, the elaboration of the vegetative system will enhance its powers of self-nutrition, so far as the parts become functional; but this is never fully realised beyond the earlier steps.

The focus of all such development is the growing point, respectively of root or shoot. Anyone who carefully dissects a suitable bud, peeling off the successively smaller leaves, may finally see with the naked eye or with a simple lens a pearly cone of semi-transparent tissue at the tip of the stem. This is the growing point itself, which possesses theoretically unlimited formative power. It is like a permanent sector of the original embryo that is fed continually from the mature tissues below, and as continually forms fresh tissues at the tip. But as the tip advances, lateral swellings of the surface appear in due order, which are new leaves and buds. Various attempts have been made to link the genesis of these outgrowths of the radial shoot with the outer world as regards their position and number. But we have it as the latest authoritative statement on this point that such a relation does not exist. "This much is proved," says Prof. von Goebel, that, "so far as we can see, the question relates to conditions of growth and symmetry that arise in the growing point. All theories as to leaf-position that allotted a passive rôle to the growing point were mistaken, however acute the reasoning that was brought to bear thereon" ("Organographie", 3rd ed., part I., pp. 299-300). This is Von Goebel's summing up for external parts. On the other hand, within the growing point, and often, though not always, related to the external parts, there is a progressive formation of internal conducting tracts, continuous from the adult region upwards to the tip. A like reference of the origin and disposition of these vascular tracts to the growing point itself appears to be equally justified. In fact, the tip possesses the initiative for both.

The complex shoot that results from such initiation is exposed as it matures to external conditions which modify its form. Their effect is very obvious in the young shoot of the higher plants. As the shoot elongates, its young tissues are soft and plastic. While in this state its form may be influenced by gravity, the incidence of light, mechanical contact, and other causes which produce reactions of form called 'tropisms'. All of these promote the well-being of the whole. The net result becomes fixed as the part matures, and its constituent tissues harden. Thus the adult form is the consequence of the primary initiation at the growing point, modified by the conditions to which the plant may have been exposed during the plastic period. This is a commonplace of the text-books. But amid all the careful analysis and experiment that has been devoted to the influences which thus affect form, one factor, insistent and unavoidable, has been habitually left out, namely, the influence of size. Reference is occasionally made in text-books to the effect of surface tension in determining the simple form in minute organisms, such as unicellular Algæ and Bacteria; and to the deviations from that simple form as the size increases, and the influence of surface tension ceases to be dominant. At the other end of the scale of size, mathematicians have calculated the extreme stature mechanically possible for a tree-trunk constructed after the ordinary plan, and of materials of known strength. The result is about 300 feet, and this coincides approximately with the limit of height of the canopy of a tropical forest. But in point of size practically the whole of the vegetable kingdom lies between the microbe and the forest tree. Unfortunately, the study of these middle terms, from the point of view of change of form as the size increases, has not been pursued by botanists with the same perception as zoologists have shown in the study of animals.

At the back of all problems raised by increasing size stands the well-known principle of similarity, which applies to all structures, inorganic as well as organic. It involves among other consequences that where form remains unaltered bulk increases as the cube, but surface only as the square of the linear dimensions. But in living organisms it is through the limiting surfaces, or 'presentation-surfaces', as they are called, that physiological interchange is effected. Provided a surface be continuous and its character uniform, it may be assumed that such interchange will be proportional to the area of surface involved. If, then, the form of the growing organism or tissue were retained as at first—for example, a simple sphere, oval, or cylinder—its surfaces of transit would increase at a lower ratio than the bulk which they enclose. There would be with increase in size a constantly decreasing proportion of surface to bulk, and as constantly an approach to a point of physiological inefficiency. But any change from a simpler to a more complex form would tend to uphold the proportion of presentation-surface. Thus the success of a growing organism might be promoted by elaboration of form. Naturally, other factors than that of size co-operate in determining form.

Nevertheless, the recognition of such elaborations of form, whether external or internal, as do tend in point of fact to maintain a due proportion of surface to bulk as growth proceeds, should help to make morphology a rational study. The diffuse form habitual for plants, even the origin of leaves themselves, becomes intelligible from this point of view.

In the construction of any ordinary vascular plant there are three of these 'presentation-surfaces' or limiting surfaces of transit, that are of prime importance : (i) The outer contour by which it faces the surrounding medium ; (ii) the sheath of endodermis which envelops the primary conducting tracts ; and (iii) that collective surface by which the dead woody elements face upon the living cells that embed them, through which water and solutes pass in or out. Each of these may vary independently of the others, and each would be a fitting subject for observation as bearing on this problem of size. But as a test case of the relation between size and form, it is the collective surface where dead wood faces on living cells that will meet our requirements best, for its study can be pursued among fossils almost as well as in living plants. The problem is one not merely of current physiology of the higher plants : it is one of adaptive progress. Accordingly, measurements must be made of the wood of fossils as well as of living plants, and of young sporelings as well as of the adult.

We have seen that plants are essentially accumulators of material. A natural consequence of this is that primitive types, endowed with apical growth but with no secondary cambium, will enlarge from the base upwards. Any sporeling fern shows this. The leaves themselves increase in number ; each successive leaf is as a rule larger than the one that came before, and the stem that bears them also expands upwards. In fact, it takes the form of an inverted cone. To grasp the size problem for primitive plants the mind must be rid of the idea of the forest tree, with its stem tapering upwards, for that is a state of highly advanced organisation. The primitive form of stem is that of an inverted cone, enlarging upwards, with a solid core of wood within. A cone standing upon its tip is obviously unpractical. Not only is it mechanically unstable, but if the original structure be maintained so that the larger region above is structurally a mere magnified image of the smaller below, a constantly diminishing proportion of presentation-area to bulk must needs follow, in respect of all the limiting surfaces. Such stems would all tend to become physiologically insufficient. Our immediate problem is with the woody column. How can that due proportion of presentation-surface of the dead wood to the living cells, which physiologists hold to be essential, be maintained in the expanding stem, so as to meet the increasing requirements of transit and distribution of the sap ?

This is not the place for a recital of the details of elaboration of the wood which have been observed and measured. It must suffice to state in general terms how primitive woody plants have met the difficulty in the absence of cambial thickening. The starting-point is a minute cylindrical strand composed of dead tracheids only. Some primitive types show nothing more than a conical enlargement of this upwards, with the cells more numerous than before. The approach of a locomotive at speed along a straight track may visually suggest such increase in size without change of form ; successive photographs of it might be compared with successive sections of those simple stems enlarging upwards without change of plan. The largest examples of this are found in some of the early club mosses and ferns, in which there is an enlarging solid woody core. But for want of resource in this and other features they have paid the penalty of death. Most plants having this crude structure are known only as fossils, and no really large vascular plant lives to-day which shows it. Under present conditions, it is only where the size is small that a simple mass of dead tracheids seems to be effective for water transit. Thus we see that simple enlargement without change of form does not suffice.

In more resourceful plants a remedy is found in elaboration of the form and constitution of the primary wood. The changes which actually appear in it, as the size of the individual or of the race increases, are very various, but they all tend towards making the wood a living whole. The most efficient state would be that in which each dead woody cell or element faces upon one or more living cells, and this structure is approached in modern types of wood. In tracing the steps which have led towards it, whether in the fossil story or in the individual life of plants, we follow up an evolutionary history of high functional import. Actual measurements and calculations have shown in living plants the advantage that follows. It has been found that changes in the elaboration of form and structure of the primary woody column have saved, in specific instances, about 50 per cent of the contingent loss in that proportion of presentation-surface to living tissue which would have followed if a simple cylindrical core had been retained. The structural changes do not, it is true, maintain the full original ratio of surface to bulk, but it may well be that saving even half of the contingent loss would bridge the acute risk and lead to survival.

The moulding and subdivision of the primary conducting tracts as a whole, or of the woody masses which they contain, present the most varied features. Their contours often appear arbitrary and even irrational, so long as no underlying principle is apprehended. They have presented a standing problem to anatomists. But when it is realised that as the size increases there is a physiological advantage in any elaboration of form whatsoever, a rational explanation is at hand. The variety of the forms assumed suggests the common principle underlying them all, which is that thereby a due proportion of presentation-surface tends to be maintained.

One of the simplest and most frequent examples of such elaboration of form is that of the fluted column, which in transverse section gives the familiar stellate figure characteristic of roots. It is also seen in many stems, and is described as 'radial'. Where the part is small the woody strand is roughly cylindrical, but where larger it often becomes fluted, with varying number and depth of the flanges. In many instances the ratio of their number to the diameter of the whole tract is approximately constant. The structure is in fact adjusted to the size. This is so in roots generally, in leafy stems, and in leafless rhizomes—and a similar size relation is even found in the fluted chloroplasts of certain Algæ. In all of these an obvious risk following an increase in size tends to be eliminated, namely, an undue loss of proportion of surface to bulk.

The somewhat technical facts thus briefly described may be taken as examples of a relation of form to size which is very general. They suggest the existence of a 'size factor', which is effective in determining form. The susceptibility to its influence resides in the part that shows the results. The internal contours are defined *ab initio*, instead of coming into existence during the course of development, as is the case with the convolutions of the mammalian brain. In the stem and roots of vascular plants the fully matured conducting tracts may be traced upwards, with their outlines already defined, through successive stages of youth towards the growing point, which has been their source. Their form may be seen already outlined in its young tissue closely short of the extreme tip. This fact suggests that the susceptibility to the size factor resides in the growing point itself, for immediately below it those tracts possess that form which will aid their function when they are fully developed.

Of all the factors that contribute to the determination of form in growing organisms, there is none so constant and inevitable in its incidence as this size relation. Its operation becomes manifest with the very first signs of differentiation of the embryonic tissues. The effects of other factors that influence form, such as gravity, light, temperature, contact, and the rest, appear later in point of time. Their influence is liable to diminish as the organism reacts to them by curvature or otherwise, and to vanish when the reaction is completed. Under experiment they may be controlled or even inhibited. But the operation of the size factor is insistent; it cannot be avoided either under conditions of Nature or by experiment, though the size itself may be varied under conditions of nutrition, and the permeability of the presentation-surfaces may not be constant, with results as yet unknown. When we reflect that all acquisition of nourishment and transit of material in plants of primary construction is carried out through limiting surfaces, the essential importance of the size factor is evident, for upon its influence the proportion of each presentation-surface itself depends.

The evidence that size itself is, among other factors, a determinant of form rests upon the constancy with which, in an enlarging organism, changes of primary form tend to maintain a due area of presentation-surface such as active transit demands. That evidence has been derived chiefly from the conducting tracts of primary individuals as they enlarge conically upwards, and from parts belonging to distinct categories, also from comparison of different individuals not necessarily of close alliance. Very cogent evidence lies in the variety of the changes of form by which the same end is attained. Finally, the converse facts bring conviction when, as often happens, a distal diminution of size in stem or leaf is accompanied by simplification along lines roughly the converse of those that follow increase.

All this shows that a real relation exists between size and primary form. The term 'size factor' has been used to connote that influence which affects form in relation to size, but without defining it except by its results. Nevertheless, we have seen that its action may be located in near proximity to the growing point, or in the embryo itself.

It has not, however, been found possible to assign to that effect an immediate cause. The attitude thus adopted towards an undoubted factor seems justified by the broad logic of science, and by the practice of its highest votaries. When Newton put together his great physical synthesis, he pointed out at the close of the " Principia " that the cause of gravitational force was unknown. " Hitherto I have not been able to discover ", he said, " the cause of these properties of gravity from phænomena, and I frame no hypotheses." Likewise, in its own more restricted field of botanical phenomena, the size factor may be recognised as effective in development, though the immediate cause of its effectiveness is still unknown.

The position thus adopted assumes the shoot to be a unit, not a congeries of 'phytons'. The elaboration of its form, whether external or internal, would be a function of the increase in size of that unit, and the result would tend to maintain the adequacy of the presentation-surfaces. This conception of the shoot and of its parts would accord with the views of General Smuts, as stated in his remarkable work on " Holism ", published in 1926. Many who heard his address in Cape Town last year, when opening the discussion on " The Nature of Life ", will value this masterly statement in brief of his theory. I suggest that the operation of the size factor, whether in relation to external leaf-development or in the elaboration of internal conducting tracts, illustrates that " measure of self-direction " ascribed by him to every living organism (" Holism ", p. 98).

The discussion of the problem of size and form in plants, which has occupied our attention thus far, raises questions of profound significance in the sphere of pure botany. There is, however, another interest inherent in the study of plants beyond that of pure science. I mean botany as applied to the needs of man. To-day this touches human life more closely than ever before. Every meal we eat, many of the clothes we wear, timber, rubber, a whole volume in itself; the drugs, narcotics, dyes, and scents, and most of that vast tale of accessories that ameliorate life, depend for their supply, quality, and often for their existence upon the skilled work of the botanical expert. He is trained in our schools and universities. His experience there is perfected by work on farms and plantations, in forests and in factories, often by adventurous life abroad. It would be superfluous for me to enter into detail on such matters, for happily the Director of Kew presides over the Botanical Section, and he can speak with the fullest knowledge on the application of botanical science to modern life.

Government departments are now linked more closely than ever with universities and technical colleges by the golden chain of grants. The botanical institutes that have sprung from this joint source are mostly focused at such centres as Kew and South Kensington, Cambridge and Oxford, Harpenden and Merton, Long Ashton and Corstorphine, Plymouth and Millport, with important outliers such as Dehra Dun in India, the Imperial College of Tropical Agriculture in Trinidad, and the Research Station at Amani, East Africa; while similar stations are to be found in Canada, at the Cape, in Australia and New Zealand. Their activities are as diverse as their position. Agriculture, forestry, plant-breeding and distribution, seed-testing, mycology, and plant pathology—these are but a few of the headings under which applied botany is now pursued; and a duly qualified staff is required for each. Kew itself, thanks to the foresight of the Empire Marketing Board, is developing ever more and more as a co-ordinating centre for the whole Empire. Highly specialised study such as this has sprung into existence in the last half-century. As regards Britain, its origin may be traced to the biological laboratory of the old Normal School of Science at South Kensington, where biological research was revived under Huxley and Thiselton-Dyer.

The first botanist there trained in pure science who turned the newly acquired vision to practical account in the interests of the Empire was Marshall Ward. For two years he investigated the coffee disease that had half ruined Ceylon. It is a long step from this individual effort in the East to the firmly established and efficient Imperial Mycological Bureau, recently housed at Kew in a new building devoted to the world-wide study of the fungal diseases of plants. Such advance along a single line of applied botany may be taken as an index of the progress from simple beginnings in pure botany to that widespread attack now being made upon the economic problems that face Imperial agriculture. The history of it thus briefly suggested may be read as a parable, showing how natural is the progression from the study of pure science to its practical application. For there is no real distinction between pure and applied science. As Huxley told us long ago, " What people call applied science is nothing but the application of pure science to particular problems ".

At the moment there is an unprecedented demand for botanical specialists to fill investigational and advisory posts at home and abroad, and there is a shortage of applicants. The realisation of this will doubtless be transmitted through the universities and colleges to the schools of the country, and lead to an increased supply. On the other hand, it lies with the Government to react as other markets do in taking steps to equalise supply and demand. A condition of the success of a specialist will always be a thorough foundation upon pure science, and this will be fully realised in the selection of candidates. Government, whether at home or in the wider Imperial field, can make no better investment than by the engagement of the best scientific experts available. In respect of botany this has been attested by many well-known instances.

Some reference will naturally be expected here to the remarkable address given by Sir William Crookes in 1898, when the Association last met in Bristol. He then forecast that, in view of the increase in unit-consumption since 1871 and the low average of acre-yield, "wheat cannot long retain its dominant position among the foodstuffs of the civilised world. The details of the impending catastrophe no one can predict, but its general direction is obvious enough. Should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us . . . just enough to supply the increase of population among bread-eaters till the year 1931." The problem is one of applied botany, with a setting of world economics and a core of physical chemistry. After raising the spectre of wheat shortage before the eyes of his audience of 1898, Crookes laid it again by the comforting words, "The future can take care of itself. The artificial production of nitrate is clearly within view, and by its aid the land devoted to wheat can be brought up to the 30 bushels per acre standard." We who are living within a few months of the fateful year of 1931 are unaware of any wheat shortage. Sir William Crookes's forecast of 1898 as to the advance in the production of combined nitrogen has been fully realised. Artificial fertilisers are not in view only, but at hand and in mass. Moreover, the northern limit of successful wheat culture has been greatly extended by the production of new strains with ever shortening period between sowing and reaping, while the establishment of new varieties is extending the productive area in South and West Australia into regions where the rainfall is of short duration, and restricted in amount.

The future, since 1898, has indeed taken care of itself; so that, notwithstanding the warning of so great a man as Sir William Crookes, the wheat-eating public is still able to sleep well at night so far as the wheat shortage is concerned. What better example than this could we desire, not only of the importance of applied botany, but as showing also how its advance follows on research independently pursued? For the production of synthetic nitrogen, which has now become a commercial proposition, and the improvement of the strains of wheat by selective breeding along Mendelian lines, are both involved in solving this crucial question of food-supply; and both owe their origin to advances in pure science.

In conclusion, we shall all be conscious of the fact that a most distinguished former president of the Association has lately passed away, one who more than any man has influenced the policy of government in relation to science. I mean Lord Balfour. We recall how in 1904 he, so thoroughly imbued with the spirit of his *Alma Mater*, presided over the meeting in Cambridge. He was distinguished as a philosopher, great as a statesman, and particularly so under the stress of war. He it was who, after peace returned, used his rare influence in transforming the war-time experiment of a committee of the Privy Council for Scientific and Industrial Research into a permanent and essential part of modern government. But this was not all. His critical, constructive, and experienced mind was led to formulate a still wider plan. A Cabinet Committee for Civil Research was to be established on the lines of the Imperial Defence Committee. He designed it so as to bring the whole national administration within the range of scientific influence. The Department of Scientific and Industrial Research, so wisely kept in being after 1919, now forms part of that larger scheme. This department is responsible for making recommendations as to the expenditure of funds voted by Parliament for research, especially in relation to industry. Thus science is welcomed into the inner circle of Imperial administration. This the State owes to Lord Balfour.

And so in this hundredth year of its existence, the British Association sees research recognised and fostered in the service of the State in a way never dreamed of in 1831, when a small body of enthusiasts met at York for the advancement of science. But though the individual seeker after truth may thus be involved in official harness, as of old an inner voice will yet speak to him. He will himself be as near to Nature to-day as he was in the simpler days that are gone.

Summaries of Addresses of Presidents of Sections.*

Terrestrial Magnetism.

THE subject of Dr. F. E. Smith's presidential address to Section A (Mathematical and Physical Science) is "Theories of Terrestrial Magnetism". He begins by referring to early magnetic conferences and resolutions urging international co-operation, but while believing the spirit of international co-operation in terrestrial magnetism to be excellent, the question is put: "Do we make our plans sufficiently well?" While it is to the International Union of Geodesy and Geophysics that we must look to plan lines of attack, Dr. Smith makes a plea for the adoption by many of the first class magnetic observatories of a programme including observations at the same time and with similar instruments of great sensitivity. Later in the address, when the question of simultaneity of magnetic storms is considered, this plea for similar instruments is revived, and the opinion is expressed that it should not be difficult to obtain a decisive answer to such a question by proper organisation. A point emphasised is that while each observatory should have its own particular problems and its own special methods of attacking them, and thus preserve its individuality, it should in addition have part of its equipment of an international type and part of its programme truly international in character.

The general character of the earth's magnetic field is described, theories relating to the permanent field being considered first. Our knowledge respecting changes in the permanent field is very limited, the secular variation being the only one of which we have trustworthy data. Schuster put forward the theory that the secular change is caused by the magnetic field inducing currents in an outer conducting medium not moving with the earth, or moving relatively to it. It is pointed out that it is not necessary to assume a large volume of outer space to have uniform conductivity to produce the effect. An outer layer will suffice and the conductivity may be uniform or patchy. The irregularities in the secular change are possibly due to the conductivity of the layer varying over considerable areas, and the relative motion between the earth and portions of the layer may also vary.

The question of electric currents circulating round the earth is next dealt with, a possible source of the electromotive force being due, as Larmor has suggested, to the existence of a residual internal circulation in meridian planes, which, cutting such a magnetic field as that of the earth, acts as a self-exciting dynamo. Another theory due to Gunn is that the inner earth has a temperature of the order of 1000°, and that it is highly ionised and a good conductor. A primary current system is supposed to be set up from the motions imposed upon ions by the internal gravitational electric field at right angles to the magnetic field, the action being a regenerative one.

The possibility of the magnetic field being due to the earth's rotation is fully considered, the associated effects of surface charge, volume charge, and gyromagnetic action being dealt with in turn. Owing to so many difficulties presenting themselves when the theories are analysed, modifications of the laws of electrodynamics have been suggested, but the theories are not satisfactory. Dr. Smith concludes that our knowledge of the cause of the earth's magnetic field is little more than conjectural, for, of the theories put forward, all that have been put to a practical test have been found wanting in some respect.

Dr. Smith then discusses vertical electric currents; while Bauer was justified in drawing his conclusions as to the existence and magnitude of such currents, the data he used are not sufficiently trustworthy. The existence of the currents is exceedingly doubtful, but sufficiently precise measurements could be made over a carefully chosen area, which would enable a definite decision to be reached.

Three theories of diurnal variation are dealt with: the 'dynamo theory', in which conducting layers of air cut the earth's permanent field and so induce electric currents; the 'diamagnetic theory', in which a diamagnetic layer is formed by ionisation, the shape of the layer being that of a hemispherical cap; and the 'drift current theory', which depends on the drift of ions and electrons in the diamagnetic layer. A direct effect of the diamagnetic layer is considered to be certain, but with it is associated an effect due to the drift currents which is much larger, and the direct effect of the diamagnetic layer is therefore considered to be of secondary importance. The dynamo theory is favoured less than the drift current theory. The other variations considered are those due to solar eclipses and magnetic storms.

The address concludes with a plea for the pro-

* The collected presidential addresses delivered at Bristol are published under the title "The Advancement of Science, 1930". The volume is obtainable at 5*s*. of all booksellers, or at the Reception Room, Bristol, by members attending the meeting, 3*s*. 6*d*.

duction of data of a more precise kind, the final paragraph quoting a passage from Rücker's address in Bristol in 1898, which emphasises the need for more perfect organisation.

A State Experiment in Chemical Research.

The subject of Prof. G. T. Morgan's address to Section B (Chemistry) is the Chemical Research Laboratory at Teddington which was originated about five years ago by the Department of Scientific and Industrial Research in order to bring together scattered groups of research workers who were then engaged in various localities on chemical investigations of national importance. The site selected on the Bushy Park Estate in close proximity to the National Physical Laboratory allows of ample scope for future expansion. Three laboratory units were contemplated originally, and after five years rather more than one half-unit has been completed and occupied.

A Chemistry Research Board advises the Department on the programme of research and exercises general supervision over its execution. Six investigations have been prescribed at various times, and are described by Prof. Morgan in the order in which they have come under his notice.

1. Synthetic resins, employed in the manufacture of moulding powders, electric components, and shellac substitutes are of growing importance in chemical industry, and since May 1925 an investigation on the production of resins from formaldehyde and the cresols and xylenols has been in progress. Resins of high dielectric capacity have been obtained and fresh information has been gained concerning the chemistry of these condensations.

2. In collaboration with H.M. Fuel Research Station a systematic study has been made of the chemical constituents of the tar derived from low temperature carbonisation. The isolation from this and other tars of four chemical groups of resins is an outstanding result of this research, which has also led to the characterisation of several methyl derivatives of anthracene contained in the less volatile oils of low temperature tar.

3. An investigation, involving a concerted effort by chemist and chemical engineer, has been initiated on the use of pressure in facilitating chemical reactions. By the interaction of carbon monoxide and hydrogen in contact with various catalysts at high temperatures and pressures, many members of the homologous series of alcohols, aldehydes, fatty acids, and esters have been synthesised. Methyl alcohol remains the predominant product, but ethyl alcohol has appeared to a not inconsiderable extent.

4. The corrosion of metals either in air or when immersed in water or salt solutions is of interest to the metallurgist and industrial chemist. Both these aspects of corrosion are under examination at Teddington. A quantitative study of immersed metals shows that their corrosion is not inherently erratic but controllable and quite a suitable subject for physico-chemical investigation.

Two noteworthy discoveries have been made during these researches in regard to the composition of the green patina which develops on exposed copper surfaces. Contrary to the belief of the last 100 years this corrosion product, as developed in England, is not basic copper carbonate but consists mainly of basic copper sulphate, the carbonate, if present at all, being only a minor constituent of the patina. Under marine conditions the basic sulphate becomes more or less replaced by basic copper chloride. Moreover, in patinas of at least 70 years' growth the composition of the basic sulphate corresponds with that of the mineral, brochantite, $CuSO_4,3Cu(OH)_2$. Similarly the marine patinas tend towards the composition of atacamite $CuCl_2, 3Cu(OH)_2$.

5. In collaboration with the Chemotherapy Committee of the Medical Research Council a group of workers is engaged in the preparation of organic compounds of therapeutic interest. Analogues of Bayer 205 or Fourneau 309 have been submitted to the Committee together with many organic derivations of arsenic and antimony. So far the organometallic series has furnished the more promising results as regards trypanocidal activity.

6. During the last two years experiments have been in progress under the auspices of the Water Pollution Research Board on the base-exchange (zeolite) method of water softening. One objection raised against this process is that the water might become contaminated with silica and alumina arising from the disintegration of base-exchange material. Experiments have shown, however, that this fear is groundless; the silica content is not increased seriously and is not greater than that often encountered in untreated waters. Along with these practical tests, a report summarising existing knowledge of zeolite water softening has been compiled and published.

In addition to the foregoing prescribed investigations a certain amount of general research has been carried out on complex aromatic hydrocarbons including acenaphthene and diphenyl, waxes and higher fatty acids, cyclic systems containing selenium and allurium, and co-ordination compounds of copper, silver, and gold.

The address is fully illustrated by an exhibit of preparations, diagrams, and items of chemical plant arranged by the staff of the Chemical Research Laboratory.

In concluding, Prof. Morgan pleads for more organised research in inorganic and mineral chemistry and in the organic chemistry of vital products. Political and economic forces are bringing into prominence the urgency for a mutually advantageous interchange of commodities between the constituent nations and colonies of the British Empire, and in this pooling of natural resources these two branches of practical chemistry must play an essential part.

Geological History of the Bristol Channel.

In his presidential address to Section C (Geology) Prof. O. T. Jones deals with some episodes in the geological history of the Bristol Channel region. Among them the Triassic planation, the formation of the Mesozoic Cover, and the Miocene earth movements are regarded as the most important. During the Triassic period, intense erosion under arid continental conditions removed an enormous thickness of Palæozoic strata which had been folded by the Armorican movements commencing in late Carboniferous times. As a result, almost even-surfaced tracts of great extent were formed bordered by escarpments, among them one on each side of the Bristol Channel. There was then no indication of a tectonic basin in the region; rather it appeared that the channel area stood at a relatively high level, thus allowing the products of erosion to be largely removed to lower-lying areas of deposition. By analogy with the escarpments along the south side of the South Wales coalfield which have been proved to be of Triassic origin, it seems that the great plateau of Central Wales around the mountain masses such as Cader Idris and others that rise steeply above its surface may have been developed mainly by desert planation in the Trias. Afterwards the Channel region and neighbouring areas were invaded by the Mesozoic seas; the probable extent of the invasion of the Palæozoic areas of the west by the sea at various Jurassic periods is discussed in relation to the lateral variation of the Mesozoic formations.

During the Upper Cretaceous, it is fairly certain that the greater part, if not the whole, of the Palæozoic region had been covered by a considerable thickness of sediments.

The Miocene movements which are so largely responsible for the physical features of the south-east of England penetrated also into the south-west, both north and south of the Bristol Channel. The variation in the present level of the base of the Lias in the Vale of Glamorgan and in the Mendip region shows that the formation has been affected by considerable folding since its deposition; the type and scale of the folding are so similar to that of the Miocene movements in the south-east of England and northern France as to tend to the belief that the movements in the west were also in the main of Miocene age. Several axes of folding have been traced from the south-east of England into the Channel region. By these movements also the ancient plain of erosion traversing the Palæozoic areas of Wales and Devon was warped.

Comparison of the physical features in relation to axes of folding leads to the conclusion that those in the west are together almost a mirror image of those in the east. Thus the central plain of Devon is a continuation of the Hampshire basin; the high ridge of Exmoor represents an upfold of the ancient plain of erosion comparable with the anticline of the Weald, while the Bristol Channel is a syncline corresponding to the Thames Basin. North of the Channel the great plateau of Wales was warped in a south-westerly direction, thus leading to many important modifications in the drainage systems of that area.

The Species Problem.

In his presidential address to Section D (Zoology) Dr. W. T. Calman discusses "The Taxonomic Outlook in Zoology". Dealing first with the primary task of the systematist, the identification and description of the species of living animals, it is pointed out that one of the obstacles to obtaining a census of the animal kingdom lies in the fact that great sections of it are so imperfectly surveyed.

The intimate personal knowledge of the specialist, which in the days of Linnæus could embrace all the species then known, can now only cover a small portion of the field, and monographs, synopses or revisions which should be intelligible to the non-specialists are not available for many important groups. Attempts at a rewriting of the "Systema Naturae", like the British Museum Catalogues or the German "Das Tierreich", cover only a small part of the ground and are rapidly becoming obsolete. Meanwhile, the successively expanding volumes of the *Zoological Record* give a picture of systematic zoology being smothered under the products of its own activity. The confusion will grow steadily worse unless systematists come to realise that the description of new species is a far less important thing than the putting in order of those that are already 'known', and until zoologists cease to regard taxonomy as a kind of menial drudgery to be performed by museum curators.

Even identification requires some kind of classification if it is only the classification of the dictionary. Since the time of John Ray, zoologists have believed in the existence of a natural system, and since Darwin it has been clear that this must be based in some way upon phylogeny. Dr. Bather, impressed by the prevalence of polyphyly and convergence, seems to think that phylogeny must be abandoned as a basis of classification, though it is not clear what he would substitute for it. Much current work and current speculation suffers from neglect of the taxonomic and phylogenetic outlook. Those departments of zoology most actively studied at the present day are preoccupied with the interplay of forces acting here and now and ignore the impressions that time may have left on the material of their study. It is as though a crystallographer studying a pseudomorph should endeavour to explain its form in terms of its chemical composition and the forces governing the arrangement of its molecules, without taking account of its history.

A few have even gone so far as to deny the existence of phylogeny. Prof. Przibram, in his theory of apogenesis, suggests that every species of metazoan has developed, independently of all the others, from a distinct species of protozoan. This is either one of the most significant results of recent biology or it is the *reductio ad absurdum* of much contemporary work. Although called a theory of evolution, it is, as regards the origin of species, no more than a doctrine of special creation at one remove. If we are to abandon belief in community of descent, the whole architecture of the "Systema Naturae" becomes meaningless.

It is significant that only on one point does Przibram speak with a hesitant voice, and that is where he mentions the geographical distribution of organisms. It is to be recalled that the opening words of the "Origin of Species" deal with geographical distribution. Przibram ends where Darwin began, and what for the one is merely the negligible residue of unexplained facts was for the other the very heart and core of the problem he set himself to consider.

Human Geography.

The subject of Prof. P. M. Roxby's address to Section E (Geography) is the scope and aims of human geography, a term now frequently employed in geographical literature, but liable to a more than ordinary degree of misconception.

The emergence and significance of human geography are discussed in relation to the modern conception of geography as a whole. The subject is of great antiquity, and the Greek view of it was in the main philosophical and scientific, but it suffered greatly from medieval formalism. It was Ritter and Humboldt who rescued what seemed to be a moribund subject and gave it individuality, coherence, and an immensely enhanced significance. This they did by claiming for it not a distinctive *segment* in the circle of knowledge—which is to destroy its very essence—but a distinctive method and objective in the handling of data common to other subjects. Ritter gave the keynote to the whole modern development of geography when he said: "It is to use the whole circle of sciences to illustrate its own individuality, not to exhibit their peculiarities. It must make them all give a portion, not the whole, and yet must keep itself single and clear." The same conception permeates the work of Vidal de la Blache, the founder of the French school of human geography, "Ce que la géographie, en échange du secours qu'elle reçoit des autres sciences peut apporter au trésor commun, c'est l'aptitude à ne pas morceler ce que la nature rassemble".

From the time of Ritter and Humboldt, workers in many fields of geography (geomorphology, climatic and biological geography, and human geography) have been guided by the same fundamental principles and methods, the central object being to exhibit the earth as a whole made up of related and interacting parts. Granted this unifying conception, the increasing capacity, on one hand, to formulate valuable and far-reaching generalisations as to the distribution and relationship of phenomena, and the imperative need, on the other, for a synthetic view of the earth, owing to the growing interdependence and inter-sensitiveness of its different regions, have inevitably increased the value and significance of geography in modern times.

Some of the principal contributions to the philosophy of human geography are next considered, and a comparison is made of the so-called 'Determinism' and 'Possibilism' of the schools of thought associated with the names of Ratzel and Vidal de la Blache respectively. The value is discussed in relation to such movements as that of regional planning of Febvre's dictum: "There are no necessities, but everywhere possibilities; and man, as master of the possibilities, is the judge of their use".

Human geography is then defined as the study of (*a*) the adjustment of human groups to their physical environment, including the analysis of their regional experience, and of (*b*) inter-regional relations, as conditioned by the several adjustments and geographical orientation of the groups living within the respective regions. The adjustment has distinct but usually closely related aspects which form the main branches of human geography. These are discussed under the terms racial, economic, social, and political geography. It is permissible and desirable to pursue special studies of these various aspects, but they find their fullest fruition when they are brought together and inter-related in a full and comprehensive 'human ecology' of regions such as Cjivič has given us in his "La Péninsule balkanique : Géographie humaine". A plea is made for the study of historical geography as essentially human geography in its evolutionary aspects.

It is claimed that the point of view and type of outlook which human geography fosters were never more needed than in the present critical stage of mankind's development. Not only through its value as an educational instrument, but also through the programme of constructive work which it advocates, can it contribute to the realisation of the ideal of 'unity in diversity', and that seems the only possible ideal for the life of humanity on a planet which, however small applied science may make it, will always retain its infinite variety.

Rationalisation and Technological Unemployment.

Prof. T. E. Gregory's presidential address to Section F (Economic Science and Statistics), entitled "Rationalisation and Technological Unemployment", examines the bearing on unemployment of that reorganisation of industry which is now commonly known as rationalisation. The terms 'rationalisation' and 'technological unemployment' have obtained a widespread currency, and this has created an unfortunate impression that the world is now confronted by vast and mysterious economic problems of a kind hitherto unknown. The problems involved are indeed of the utmost importance, but when their character is analysed, it will be found that they derive their importance more from a change in scale than from the novelty of their nature.

The name of rationalisation has been given to a conscious process of industrial reorganisation which is taking place throughout the world, and of which the characteristic results are a growing control over markets, an increasing standardisation of processes and product, and a greater output per worker. These changes economise the amount of labour *directly* required per unit of output and effect, in so far as the distributive services are rationalised, a net reduction in the amount of labour required to place a unit of output in the hands of the final consumer. Given this trend, it may be asked does rationalisation inevitably cause unemployment as the result of the technological reorganisation involved ?

Similar problems were discussed by the classical economists under the title of "The Influence of Machinery upon the Conditions of the Labouring Classes". They resolved the problem into its constituent parts, and these are still the fundamental issues to be faced. Does rationalisation involve unemployment (*a*) in a single industry, (*b*) in all industries taken together ? Or is there some 'inherent' principle of human nature which will solve the problem, after transitional effects have been overcome ? To-day we are again forced back upon general economic reasoning because the available statistics only suffice to establish a presumption that rationalisation has been responsible for part of the existing unemployment.

Since the rationalisation movement is international in character, and since it generally reduces cost per unit of output, no single country engaged in international trade can hope to contract out of its consequences. This in itself is sufficient reason for pushing ahead with rationalisation in Great Britain.

In the short run, rationalisation is not a remedy for unemployment, and on the contrary it may increase unemployment except to the extent that it stimulates demand in the constructional and equipment industries. In the long run, since rationalisation effects a lowering of real costs, there is no reason to suppose that the volume of unemployment will not again fall. It is impossible, however, to tell in what directions an increased demand for labour will manifest itself. Possibly in the future the occupied population will be less industrialised than in the immediate past. In this transition, whatever form it may take, a grave transfer problem is involved, and therefore the first and most obvious ameliorative measure must be an increase in the mobility of the working population.

Interdependence of Science and Engineering.

The presidential address to Section G (Engineering) by Sir Ernest Moir is entitled "The Interdependence of Science and Engineering, with some Examples". It begins with some interesting personal appreciations of some of the eminent engineers of the past, but in general is an attempt to indicate the interdependence of the engineer on the science of the physiologist, the bacteriologist, the economist and the all-important science of finance, all of which enable the engineer to carry out his destiny by entering new paths and opening up, by the aid of railways and roads, vast areas, to enable them to be made fruitful and suitable habitations for his fellows.

The three main sections of the address deal with (1) voids, (2) bacteriological and entomological sciences and their influence on civil engineering, and (3) economics of engineering construction. The influence of air- and water-filled voids is felt in such widely different instances as the combustion of fuels, the action of explosives, the drainage of subsoils, and the solidity of great marine structures subjected to the action of the sea. Special reference is made to the great breakwater at Valparaiso founded in 187 feet of water, upon a sandbank deposited by dredgers which has so consolidated itself that the fluke of an anchor let fall upon it does not penetrate its surface. Upon the sandbank have been placed layers of quarry rubbish and selected rock upon which rest 60-ton blocks. During a storm, a small movement of these blocks took place and this was attributed to the falling masses of water acting as hydraulic rams in the voids between the blocks. This is but one example which goes to show that the exact action of the sea on structures is waiting the solution of the scientific worker to determine what forces exist and are exerted by moving masses of water in great storms.

The execution of many great engineering works, such as the Panama Canal, has been possible only through the discoveries of Manson, Bruce, Ross, and others in connexion with the disease-carrying power of mosquitoes. During the construction of the Port of Para in Brazil, yellow fever was not entirely eliminated but there were few deaths. Research, however, is necessary on the Varugus disease, which causes trouble in the Varugus Valley through which the Central Railway of Peru runs ; on bilharziasis, which is hindering the work on the dams and canals on the Blue and White Niles ; and on blackwater fever, sleeping sickness, and the tsetse fly. Caisson disease, diver's palsy, or 'bends' has been largely prevented by the decompression method first used in the Hudson Tunnel, New York, in 1890–92 ; here the civil engineer has helped the science of medicine, thus making a return for some of the benefits received from the bacteriologist and medical man.

The third section of the address, on the economics of engineering construction, is a brief sketch of the various points which have to be considered by the contracting engineer, written with special reference to the carrying out of large civil engineering enterprises abroad and mostly undertaken for foreign governments.

Evolution in Material Culture.

In his presidential address to Section H (Anthropology), Dr. H. S. Harrison outlines and discusses a point of view, and an analytical method, in relation to the processes and steps through which the evolution of man's material culture has been effected, both subjective and objective aspects of various problems being considered. Stress is laid upon the predominant part played by opportunism in discovery and invention, and upon the extremely limited range of human foresight ; aims and ends, as well as ways and means, are products of evolution, and only come into view as they are closely approached by an opportunist route. It is suggested that the "common faculties of the human mind", upon which so much weight is often carelessly laid, are so general in their nature, and so limited in their working by the conditions of the natural and artificial environment, as to be incapable of bringing about similarities in the products of discovery and invention, except in very simple cases. Man has always and everywhere an environmental mind, and environments differ so greatly that starting-points and opportunities are rarely the same, or even similar, except within the limits of common or intercommunicating cultures.

In the analysis of discovery and invention, a discovery may be regarded as a subjective event, which may or may not be applied objectively to material ends, and it is with applied discoveries alone that the technologist is concerned. These play a relatively smaller part in the evolution of artefacts or inventions, than in that of the methods and processes which constitute techniques, which may be called discovery-complexes. Artificially prepared substances, such as bark-cloth or bronze, may be termed discovery-products. All techniques owe their character to discoveries, few or many, usually of necessity following each other in a certain sequence, and parallelism in evolution ('independent invention') makes a big demand on coincidence, except where the sequence is short.

The term inventions, in its general vague sense, may be applied to all shaped or constructed artefacts, without prejudice to the need for a clear definition of the true inventive process and of the 'inventive step'. The 'small modifications' which have long been recognised as steps in the evolution of artefacts, are placed in two chief categories—those which may be called *variations*, no one of which produces an important change in the artefact in which it appears, though by summation the final result may be conspicuous ; and those which represent definite and discontinuous steps in advance, and which may be called *mutations*. Variations may be casual, selective, or adaptive, and they do not necessarily influence functional efficiency ; mutations, on the other hand, are always selective and adaptive, and their purpose is to increase efficiency. Two well-defined kinds of mutation can be identified ; (1) those which owe their origin to discoveries made during the manufacture or use of the artefact involved (free-mutations), and (2) those which result from a prediction that an artefact may be improved by grafting on it a feature or a device which has developed in another context (cross-mutations). Since free-mutations arise out of discoveries, they are not inventions, and this term, in the strict sense of single inventive steps, may be confined to cross-mutations. From this point of view, true invention is a process of combination or hybridisation, in which foresight is necessarily involved.

The system of analysis proposed does not provide definite criteria for decisions on questions of independent evolution, but it enables a clearer conception to be formed of the evolutionary process, and of the probable discoveries, mutations, and variations, which have been traversed in sequence by material products of human ingenuity and industry. The general conclusion is strongly against the prevalence of independent evolution, on any significant scale, as a factor in human progress.

The Synthetic Activities of the Cell.

Prof. H. S. Raper's presidential address to Section I (Physiology) deals with the processes of synthesis in the animal cell. Up to the present the catabolic activities of the cell have yielded more to the investigator than the anabolic. This is largely due to the fact that the former may be studied after death, whereas the latter are essentially those which occur only during life. Methods of experiment are thus very limited.

The great importance for physiology of elucidating the structure of organic substances produced by living organisms is emphasised and the debt due to organic chemistry for this is acknowledged. The usual synthetic methods of the organic chemist can, however, seldom have place in the living cell, owing to the severe limitations imposed by its extreme sensitiveness to environmental changes. The raw materials for synthesis are also very limited.

Our knowledge of the modes of synthesis of some of the more common components of animal organisms is dealt with. These include the bile acids, cholesterol, and the purine bases, where the raw material for synthesis cannot yet be said to have been ascertained. The possible synthesis of adrenaline from tyrosine and phenylalanine, to which it is closely related structurally, is discussed and the difficulties of the proof that such a process takes place in the cell are pointed out.

The synthesis of fat from carbohydrate, which was established by Lawes and Gilbert seventy years ago, is an instance in which the raw material for the synthesis is known with certainty but the chemical transformations involved are as yet obscure. A brief summary is given of the types of reaction which may well account for this synthetic process and the possibility of their occurrence in the cell is discussed.

The synthesis of glycogen is next dealt with. The evidence for and against its production by enzyme action is considered and it is concluded that the available information makes it probable that more than a mere reversal of enzyme action is concerned. This synthesis has so far never been obtained except in the living cell, and it seems probable that the substances from which glycogen is produced must at some stage form an integral part of the living protoplasm.

The raw material for protein synthesis, like that of glycogen, is known, but the mechanism by which the amino acids are joined together to form the very varied proteins which are produced by animal cells can only be guessed at. Here, again, the reversal of action of proteolytic enzymes has been invoked to account for the synthesis; but even if this did occur, it leaves the major difficulties unexplained. Protein synthesis, like that of glycogen, only occurs in the living cell, and the problem of its mechanism will probably only be solved when we know how protoplasm itself is produced. It is possible that cyclic changes in the cell may account for the production, time after time, of a protein of unvarying pattern. The change of an enzyme or its 'carrier' in cyclic fashion might produce changes of configuration which would lead to particular syntheses occurring optimally at various phases of the cycle.

The question of the site of protein and other syntheses in the cell is not without interest; it is possible that the nucleus of the cell is the main seat of synthetic activity. Many of the problems concerned in synthesis in the cell are problems of organisation, and for their solution a much more satisfactory objective picture of cell structure than we possess at present is essential.

Foundations of Child Psychology.

In his presidential address to Section J (Psychology) Prof. C. W. Valentine discusses the foundations of child psychology and their bearing on some problems of general psychology. He opens by enumerating the values of the study of the early years as: (1) the fascinating interest for those who love children or who marvel at the wonder of the developing mind, (2) to throw light on what is innate in the human being, (3) to counteract the tendency to interpret later childhood on the lines of adult experience, and to act as a check on the tendency to rationalise adult behaviour.

In recent times three schools of thought have devoted special attention to the study of early life. Psycho-analysts maintain that the first four or five years are the most important in the fixing of character. The behaviouristic school asserts that there are few genuine innate tendencies in man, and holds that any infant, if taken in hand early enough, can be 'conditioned' into almost any type of character. Lastly, the pioneer work of Dr. Arnold Gesell has provided tests suitable for infants of a few months old, and he claims that the results of such testing afford some evidence of correlations with normal mental development. Such tests, however, are themselves in need of testing, since little work has been done with young children and the present testers of young children are in the position of the testers of older children about twenty-five years ago.

Some criticisms that can be made are: (1) that the child of twelve months may be able to do some of Gesell's tests for the two-year-olds and yet fail in some of those for his own age; (2) that the tests are too dependent on the passing mood of the child; (3) that although Gesell maintains that fatigue and illness do not completely mask the stage of development, yet this would seem to be true only of the well established reflexes and not of the *nascent* functions.

As a result of a careful study of thought in little children, one is left with a strong impression that elementary thought processes appear very early. Evidence is brought forward that the spatial relation, causal relation, relation of likeness, and relation of evidence are apprehended at about three years of age. This is in direct opposition to the view of Piaget, who would not place such processes before the age of seven. It is necessary to guard against the assumptions that thought only develops when the corresponding word is used and that one word used by a child must necessarily have the same content of meaning as when used by an adult. These thought processes, though, only appear at first sporadically, hence the necessity for careful daily observation in the child's own environment.

The outlook for the future is hopeful, and we may look forward to being able to test at about six months old a child's intelligence, its capacity for linguistic development, and its probable characteristic temperament. It must be admitted, however, that the field of infant psychology is still largely unexplored and that the method and technique are greatly in need of improvement.

Problems in Taxonomic and Economic Botany.

Dr. A. W. Hill's presidential address to Section K (Botany) is entitled "Present-day Problems in Taxonomic and Economic Botany". In his opening remarks he refers to the work of J. S. Henslow, Thiselton-Dyer, and Harold Wager, and compares their services as teachers of botany. He then discusses some of the present-day problems in systematic botany connected with the 'species concept' and the work of our great herbaria. Reference is made to the prevalence of hybridisation in New Zealand and to the work of Dr. Cockayne and of Dr. Lotsy and to the important effects on taxonomic work which must result from the fuller recognition of natural hybrids.

The question of physiological varieties is also referred to, and examples are brought forward from South Africa, in connexion with physiological varieties of *Pentzia* and *Salsola*, and of *Eucalyptus* in Australia, and other plants. The need of careful experimental work in connexion with taxonomy is emphasised, and a general review of the experiments that have been made in cultivating plants at different altitudes and under different soil conditions is given. Particular attention is paid to the work of Turesson in Sweden, and to the work which is being carried out in England, in co-operation with the British Ecological Society, at Potterne, in Wiltshire. These experiments are showing that, with individuals of known genetic origin, some remarkable changes can be produced when certain plants, particularly *Plantago major* and *Silene maritima*, are grown on different types of soil. The soils used in the Potterne experiments are clay, sand, calcareous clay, and calcareous sand. The importance of keeping accurate records in herbaria of the plants used in connexion with genetical and hybridisation work is referred to, and an account of the arrangements that are being made at Kew in these directions is given.

With regard to economic botany, some particulars are given of the interesting observations which have been made of the flower behaviour of Avocado pears in America, and also with regard to the fertilisation of the date palm, and the economic importance of physiological varieties is pointed out in such economic plants as para rubber, camphor, and *Eucalyptus dives*, the essential oil of which is used for the manufacture of thymol and menthol. Attention is also directed to the tung oil trees (*Aleurites*) which are now being introduced to our Dominions and Colonies, since it seems likely that they also may show various physiological types.

The importance of combining herbarium work with studies in the field is emphasised, and an account is given of the new activities in this direction which are being carried out at Kew, thanks to the grant made for this purpose by the Empire Marketing Board.

In conclusion, attention is directed to the need of more and better-trained workers in the fields of taxonomic and economic botany. The question of recruitment is discussed in the hope that it may be possible to widen the interest in biological science among those who are now being trained in the schools and universities of Great Britain.

A Policy of Higher Education.

Lord Eustace Percy's presidential address to Section L (Educational Science) is a plea for an appreciation of realities. What, in the rapidly changing conditions of contemporary life, are the changes actually required to enable our schools to meet the higher educational needs of the individual boy and girl?—needs which are largely determined by the character of the services society will demand of them when they leave school. There is a tendency to-day to assume that full-time schooling up to sixteen years of age must be good for everyone, and that all we require is a sufficient variety of schools and curricula. The assumption ignores the fact that higher education worthy of the name is the very antithesis of the 'forcible feeding' largely and necessarily prevalent in the elementary stage.

Higher education cannot work by compulsion, and the attempt to force pupils through this stage is foredoomed to failure. We are in face of an imminent danger of the methods of elementary education being pushed up into the higher sphere, wherein should be paramount the influence of "those standards of academic freedom and intellectual authority which it is the peculiar function of the universities to maintain". Now, the university and technical college are in a special sense the mediators between the schools and society's demand for their product. The key to a new policy in higher education is the popularisation of the idea, already familiar to university appointments boards, that industry is the chief, and indeed the only direct, agent of social welfare. In supplying to it men trained for its practical requirements, the universities and colleges will be merely fulfilling their traditional function of synthesising research into doctrine and keeping new learning up-to-date with new knowledge. Their courses of training should be designed to react upon industrial practice, and their designers should aspire to acceptance by industry not merely as subservient trainers but as intelligent advisers. It is by such acceptance that American industry has been helped in some directions to eclipse that in Great Britain.

How are we to interpret industry's demand as conditioning practical measures of school reform ? It is a demand for mental keenness rather than for physical skill, and though there are signs of a revival of the craft element in, for example, the furniture industry, it is broadly true that the demand for manual labour, skilled or unskilled, is giving place to a demand for labour involving at least some measure of abstract thinking and planning. This points to longer schooling. It would be a mistake, however, while we are still in this transitional stage, to risk starting the full-time schools of the future on wrong lines by forcing them to assimilate a mass of pupils who would stay on at school with no clear object. Our first aim should be to develop part-time education in technical schools and continuation classes for all children over fourteen.

The Hadow Report ideal of four-year courses of full-time schooling for all from eleven to fifteen years of age should be expanded into the wider ideal of five-year courses from eleven to sixteen, the first three in full-time schools and the last two either in full-time or part-time according to the pupil's needs. The full-time school should at every stage work in with the technical school so that the five-year course may be made a really continuous one. Above this stage there will be our traditional type of secondary school and our senior technical courses, bringing the pupil up to the college stage of higher education whether in the technical college or the university.

Veterinary Science and Agriculture.

Dr. P. J. du Toit, the director of Veterinary Services and Animal Industry for the Union of South Africa, in his presidential address to Section M (Agriculture), gives a general outline of some of the most notable achievements of veterinary science in recent years, and indicates the close relationship between this science, agriculture, and other sciences.

In the group of diseases caused by trypanosomes considerable progress has been made both in the treatment of infected animals by means of drugs, and in the campaign against the transmitter, the tsetse fly. Nevertheless, Dr. du Toit urges that the work be supported more liberally, since these diseases are holding up the advancement and civilisation of Africa.

Similar progress can be recorded in the elucidation of and the fight against the diseases caused by piroplasms. Drug treatment of some of these diseases is eminently successful. In others, for example, anaplasmosis, satisfactory methods of immunisation have been found. In yet others, reliance has to be placed on the control of the transmitting agent, the tick. The discovery of the rôle played by the tick in the transmission of these diseases is one of the landmarks in the history of biological science.

Amongst the diseases caused by ultra-visible viruses, rinderpest is a good example of a disease which has been eradicated from most countries by the application of modern methods. Great advances have also been made in the study of foot-and-mouth disease, rabies, and many other members of this group. Similarly, recent advances made in the science of bacteriology have rendered possible the control of various bacterial diseases, such as glanders and pleuro-pneumonia. Considerable interest is now centred on the problem of tuberculosis ; work recently carried out in many countries with the so-called B.C.G. vaccine of Calmette and Guerin seems to indicate that a new weapon against this disease has been found.

Dr. du Toit further refers to the great importance of internal parasites (worms) to the livestock industry. Very good results have been obtained in the case of some of these infections (for example, stomach worms of sheep, *Hæmonchus contortus*) by means of drugs. Emphasis is laid on the fact that all available scientific knowledge must be applied to the control of parasitic worms, or else the sheep farming industry will be ruined. Great progress has also been made in the eradication and control of diseases caused by external parasites and poisonous plants. The problem of deficiencies, especially mineral deficiency in animals, is briefly referred to and it is shown how the cattle breeding industry has benefited from the application of the results of recent research work on this problem.

In conclusion, Dr. du Toit mentions the importance of nutrition and breeding for the livestock industry, and indicates how these problems are inter-related with the problems of animal disease. He pleads for further research on all these problems, and shows how South Africa has profited from the results of work carried out at the Veterinary Research Laboratory, Onderstepoort, Pretoria.

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Bristol more than Lord Justice Sir Edward Fry, F.R.S., the great international lawyer, who was born in Union Street, Bristol, and was a local naturalist of national reputation; John Samuel Budgett was a well-known local naturalist; while the third meeting in Bristol of the British Association, which took place in 1898, will always be remembered for the remarkable presidential address of Sir William Crookes, in which he directed attention to the limitations to the world's wheat supply and forecast the production of nitrogenous fertilisers from the air.

Recent Hydro-Electric Developments in the Alps and the Apennines.

By Dr. Brysson Cunningham.

The widely extended and systematic exploitation within recent years of the valuable water power resources of Switzerland and Italy, hitherto lying latent among the mountain chains of the Alps and the Apennines, is one of the most striking features in connexion with the modern industrial and commercial developments of the countries in question, and it has been, and is being, attended by economic repercussions affecting various nationalities, including our own. Coal, the usual source of energy for power purposes where it can be mined, is lacking as a natural deposit, and, in the past, manufacturers using mineral fuel have had to rely in the main on importations from abroad, a very considerable portion of which came from Great Britain (South Wales and the Tyne district). The acute experience during the War, when these external supplies were cut off, brought home to the Swiss and Italian peoples the necessity of finding some internal means of making good a deficiency which tended to hamper, and even to paralyse, their industrial activities and placed them at the mercy of foreign interests. Not surprisingly, their attention was directed to the great potential value of the streams and lakes in the mountainous districts, where an untold quantity of water lay ready for utilisation and was capable, in a very large measure, of meeting commercial and industrial needs. These elevated reservoirs and mountain streams could be harnessed so as to produce electric current, which, in turn, could be distributed far and wide to suitable points of application.

The visitor to northern Italy and Switzerland at the present time cannot fail to notice the growing network of transmission lines which is spreading over the face of the country, scaling mountain flanks and ridges, traversing hills, valleys, and plains, and linking up cities and centres of population with an enormous spider's-web of copper and aluminium wire. Where, in past days, the landscape's most conspicuous artificial features were picturesque campaniles and church steeples, there are now to be seen, in challenging competition, lofty steel-framed pylons and standards, ranged in long files which, like the telegraph poles alongside a railway track, attend the traveller throughout his journeys.

The utilisation of water power for the generation of electricity, or rather its systematic exploitation for the purpose on a large scale, is a comparatively recent enterprise. Until the close of last century electricity was generated almost entirely by steam power. Canada—a country similarly handicapped to Italy and Switzerland in regard to its lack of natural coal deposits—which has now no less than six million water horse power harnessed to its electric generating stations, possessed in 1900 less than 250,000 realised horse power. In Italy, pioneer steps were first undertaken towards the end of the 'eighties, when in 1888 the city of Trento installed a plant of 500 kw., and between 1892 and 1895, when at Tivoli and Paderno scarcely less modest installations were inaugurated, the former to supply current to Rome at 5000 volts and the latter to Milan at 13,000 volts. It may be affirmed that these small undertakings marked the initiation in Europe of the great movement in hydro-electric exploitation which is so actively in progress at the present time throughout the world and has revolutionised in no small measure the methods and operations of manufacture and industry.

In this and two succeeding articles it is proposed to give a brief description of the conditions and present position in regard to hydro-electric developments in Switzerland and Italy, and to set down certain personal impressions formed during a recent series of visits to some of the leading and most modern installations.

Both countries have mountain systems of great magnitude and extent. The towering heights attained by the ranges have naturally a very marked influence in conferring a notable degree of head, or pressure, on supplies of water which can be collected, diverted, and utilised for power purposes. In this respect, however, it is desirable to point out a distinction between the two classes of mountain ranges. The essential characteristic of the Alps is their abundance of glaciers, with extensive areas of frozen snow and ice, which cover their summits and topmost slopes practically in perpetuity. From the gradual and periodical melting of these masses of ice and snow come the streams and waterfalls which constitute so charming a feature of the landscape. But the flow is intermittent and limited to those seasons of the year in which the temperature is sufficiently high to cause thawing. In other words, it is only during the summer months that supplies of flowing water from these sources are available. During the rest of the year they are imprisoned in a solid state.

Fig. 1 shows a view of the Piz Palü and the Palü Glacier in the Bernina Range, one of the sources of supply of the Brusio Power Works in the Canton of the Grisons, Switzerland.

In the Apennines, on the other hand, there is an absence of glaciers and very rarely do these heights

FIG. 1.—Piz Palü and Palü Glacier, Bernina Range, Canton of the Grisons, Switzerland. By courtesy of the Brusio Kraftwerke, Poschiavo.

reach the level of perpetual snow. The consequence is that, as regards water supplies, an entirely different regimen prevails. It is not from glaciers and snowfields that the watercourses of the defiles and valleys are fed, but from the ordinary rainfall, which is seasonal and chiefly in evidence during the autumn and winter, whereas the summer precipitation is slight.

The difference may be summed up by saying that the hydro-electric installations among the Alps are, in general, actuated by lofty heads and small (even, in some cases, exiguous) supplies, with a service which is only fully effective during the summer, whereas those among the Apennines have a more moderate fall with better and more copious supplies, frequently in association with impounding reservoirs in the lower levels, the seasonal activity being most pronounced during the autumn and winter.

Impounding reservoirs, however, are not limited to the Apennine regions: they are also a feature of certain Alpine installations, though in that case they are located at considerably increased heights, and their area is naturally more circumscribed. Moreover, they have been formed under greater constructional difficulties than those on the lower slopes, which, although in some cases requiring dams of greater length, are more readily and easily accessible. The impediments in the way of the conveyance of material and the carrying on of works in the higher regions are obviously very great and the cost of such operations is correspondingly heavy.

In the formation of storage reservoirs, regard has naturally been had to the possibilities of utilising the configuration of the district to the best advantage. Despite the existence, however, among the mountain ranges of quite a number of natural lakes which form admirable reservoirs of water suitable for power purposes, the physical conditions have not always been favourable, and, the distribution being irregular, in many cases, use has had to be made of other sites which have required extensive constructional operations in order to develop them adequately as basins of supply. Some of these artificial basins, especially those of low or moderate altitude, are of remarkable size; there are about fifty or so in Italy alone, each containing more than one million cubic metres of water. Perhaps the most notable of recent years is the reservoir of Tirso, in Sardinia, which has a maximum capacity of about 400 million cubic metres.

One of the earliest examples is the reservoir at Cismon, in the province of Belluno, by means of which the Società Adriatica d'Elettricità has been able to impound four million cubic metres. It possesses some interesting features. Constructed between 1905 and 1908, and the first of its type in

FIG. 2.—Cismon Dam. By courtesy of the Società per l' Utilizzazione delle Forze Idrauliche delle Veneto.

Italy, the masonry dam, which is shown in Fig. 2, is in the form of a slender arch supported by rock abutments on each side so closely adjacent that the chord of the arc is only 40 metres in length. The thickness of the dam at the top is 3 metres, increasing to 12 metres at the base. The height is 44 metres. The overflow, sometimes 2 metres in depth, passes over a rectilinear crest supported by the flanks of the dam and a central pier. The conduit to the power station (shown in Fig. 3) takes the form of a tunnel 1½ kilometres in length, at the end of which are two pressure tubes of 1·9 metre diameter. These, with a fall of 52 metres and a flow of 18 cubic metres per second, feed two generators, the joint capacity of which is just under 10,000 horse power.

Another point to which attention may be directed as characteristic of both Alpine and Apennine installations, arising out of the intermission of their supplies, is that for the purpose of securing constant supplies of power it has been necessary to supplement them in a number of cases by 'thermic' or steam generating stations, in which current is generated by power derived from the consumption of fuel. Thus it will be seen that, as distinct from purely hydro-electric power stations, such as those in eastern Canada, which are more or less in constant action under the energy derived from streams and rivers at low altitudes with plentiful supplies of water, the power stations of northern Italy are worked in conjunction with thermic stations which come into operation when the natural water power is suspended or is insufficient. These two sets of stations have to be connected and linked up in a compensatory system, which complicates matters a little more than would be the case if the energy were forthcoming from a single source. The six leading hydro-electric systems in the Italian peninsula, namely, the S.I.P. (Società Idroelettrica Piemonte), Edison, Adamello, Adriatica, Central and South Groups, have six thermic stations, at Turbigo, Genoa, Raconga, Marghera (Venice), Leghorn, and Naples respectively.

Attempts have been made from time to time to determine within reasonably close limits the total available supply of hydraulic energy in various countries. In all computations of this kind there is much scope for error, due to the unreliability and insufficiency of the data at hand. Conclusions, therefore, have necessarily been of the nature of mere approximations, subject to correction as further investigations have been made and the results of actual utilisations have become known. At the present time, estimates are still too vague to permit of any close or rigorous figures, but for the purposes of this notice it may be said that such statistics as are published lead to the conclusion that the available water horse power of Italy is of the order of five to six millions,[1] and that of Switzerland rather less—say four millions.[2] These figures must be taken with reserve; they are probably, almost certainly, under-estimates, but they may serve as the basis of an interesting comparison with similar estimates applicable to Canada, where, as noted in a recent article in NATURE,[3] the available horse power is calculated to exceed forty millions. On the other hand, the area of Canada is more than thirty times as great as Italy and 233 times as great as Switzerland. Accordingly it will be seen that, despite the magnitude and impressiveness of the developments which have been proceeding on the North American continent, the potential intensity of development on an area basis is much greater in the European countries.

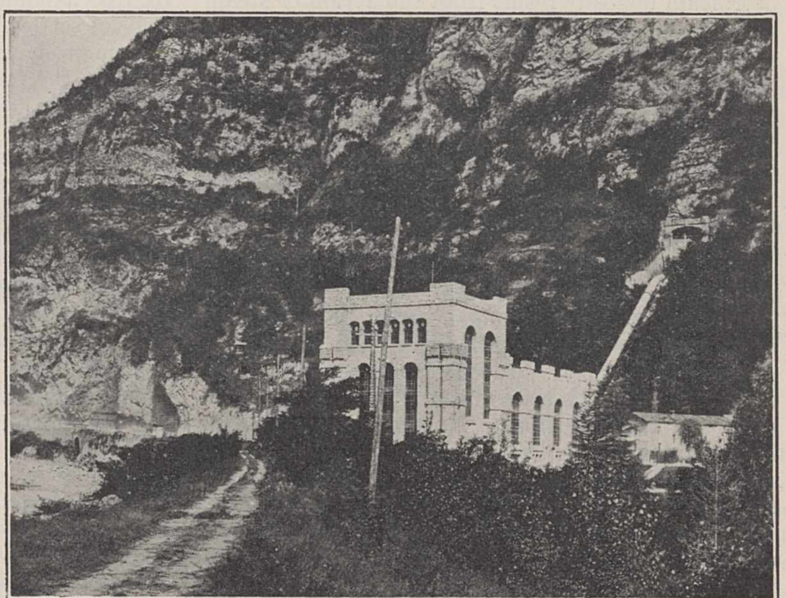

FIG. 3.—Cismon Power Station. By courtesy of the Società per l' Utilizzazione delle Forze Idrauliche del Veneto.

During 1929, some 400,000 additional water horse power was installed in new, or extended, hydro-electric stations in Italy, bringing the aggregate of installations up to about 4½ million horse power. The latest available figures for Switzerland indicate that some 2½ million horse power had been realised in various installations up to the end of 1929. It must be admitted, however, that the difficulties in the way of instituting an exact census of all installations, large and small, public and private, direct acting and transmissional, are such that the returns, while substantially correct, may not be quite precisely so. At a stage when progress is rapid and the situation changes from month to month, absolute accuracy is, perhaps, of no great account.

[1] *Vide*, Table IV., "Power Resources of the World"; published by London World Power Conference, 1929.

[2] This is the official estimate of the Swiss Service des Eaux as contained in the *Rapport du Conseil Fédéral sur sa Gestion en 1929*. A much higher figure is given in the London World Power Conference Report.

[3] May 31, 1930.

Obituary.

J. A. LE BEL, FOR.MEM.R.S.

THE death of Joseph Achille Le Bel, which occurred in Paris on Aug. 6, removes a veteran who had been closely associated with the rapid development of organic chemistry during the latter part of the last century. Le Bel was born at Pechelbronn, Alsace, on Jan. 21, 1847, and was a nephew of Boussingault, the agricultural chemist. He was a student at the École Polytechnique from 1865 to 1867 and became successively assistant to Balard, the discoverer of bromine, at the Collège de France, and to Würtz, at the École de Médecine, in Paris. For some time he was in charge of the petroleum workings at Pechelbronn, in which his uncle was interested; he became and remained an ardent partisan of Mendeléeff's view that the petroleum deposits result from the action of steam on metallic carbides at volcanic temperatures.

Le Bel holds an honoured position in the history of science as one of those eminent French natural philosophers who discovered and worked out the earlier consequences of optical rotatory power. Arago observed in 1811 that the plane of polarisation of a beam of polarised light is deflected by passage through a plate of quartz cut perpendicular to the optic axis; in 1815 Biot found that certain organic liquids, such as turpentine, are also optically active in the same sense. In the 'fifties and 'sixties, Pasteur concluded from his classical investigation of the tartaric acids that the optical rotatory power of aqueous solutions of these organic compounds arises from asymmetry of their molecular configurations. No progress was made, however, in the problem of ascertaining the definite arrangement in three-dimensional space of the atomic components of optically active molecules, called for by Pasteur's fundamental conclusion, until the doctrine of the asymmetric carbon atom was enunciated.

The theory of the asymmetric carbon atom was put forward independently and practically simultaneously by van 't Hoff and Le Bel in 1874; after a brief period of discussion, accompanied by a certain amount of lively ridicule, the theory became universally accepted and to-day forms the foundation of the vast subject of the stereochemistry of carbon compounds. The theory was evolved in a somewhat different fashion by its two authors. Van 't Hoff proceeded from the assumption that, in such a molecule as that of methane, CH_4, the four valency directions of the carbon atom are directed from a centre, representing the carbon atom, towards the apices of a regular circumscribing tetrahedron, the four hydrogen atoms being centred at those apices. In the substitution derivatives of methane of the types, CX_3Y, CX_2YZ, X, Y and Z being univalent radicles, no isomerism should exist if the four radicles lie at the apices of the tetrahedron as foreshadowed by the theory; when all four radicles attached to the central carbon are different, as in the type CWXYZ, two isomerides should exist, the space configuration of one being the mirror image of that of the other. A carbon atom so attached to four different radicles is termed asymmetric, and, in accordance with the conclusion of van 't Hoff and Le Bel, all substances which contain one asymmetric carbon atom in the molecule have been found to exist in two mirror image, or enantiomorphously related, configurations, of arithmetically equal but algebraically opposite rotatory powers.

Le Bel arrived at the theory in a somewhat different manner. He discussed the mode in which the four univalent radicles attached to a quadrivalent carbon should arrange themselves as a pure question of equilibrium, and hence arrived at the tetrahedral environment of the central carbon atom with the same consequences, as regards asymmetry, as those of van 't Hoff. It is not yet settled whether van 't Hoff's view, that the carbon atom carries four valency directions directed towards the four apices of a circumscribed regular tetrahedron, is preferable to that of Le Bel, but the tendency of modern organic chemistry is certainly towards the Le Bel implication that the four carbon valency directions are not so fixed. Probably, however, both men were making in 1874 an incomplete statement of the same thing; although more than half a century has elapsed, it is not yet possible to state the theory of the asymmetric carbon atom in more definite and explicit terms than was done at that date.

Le Bel was the first to separate an optically active component from the synthetic mixture of the two mirror image components of a compound containing an asymmetric carbon atom; he did this in most cases by taking advantage of the selective destructive action of lower organisms on the laevo- and dextro-isomerides. He was also the first to show that when the asymmetric carbon atom of an optically active substance of the type, CWXYZ, becomes symmetric by conversion into the allied compound, CX_2YZ, the optical activity disappears.

Later, Le Bel extended his stereochemical conceptions to quinquevalent nitrogen compounds and announced in 1891 that he had been able to obtain optically active methylethylpropylisobutylammonium salts; this observation could not be confirmed by others, and is no doubt mistaken. The laboratory technique for dealing with such complex substances had not then been sufficiently worked out, and it was not until 1899 that the first optically active substituted ammonium salts containing an asymmetric quinquevalent nitrogen atom, but no asymmetric carbon atom, were first prepared.

Le Bel did not publish a great amount of experimental work, probably because he held no academic post and so found few collaborators; his writings cover, however, a wide range of subjects and are permeated by a quite uncommon philosophic spirit. He was an individualist and mixed little with his scientific colleagues; he was intolerant of officialdom in any of its aspects, and was wont to express his contempt of bureaucracy with some vigour. His originality of thought, his outspokenness, and his unconventionality, indeed bohemianism, made him somewhat difficult of access, but in congenial society he was a delightful companion, full of knowledge of the world and sparkling with anecdote and caustic wit. He maintained his interest in science to the end, and, so late as April last, offered a money prize for the rediscovery of a microscopic green alga, found and lost by him, which had the power of converting atmospheric nitrogen into ammonia.

Le Bel was president of the French Chemical Society in 1892; he was a Commander of the Legion of Honour and a member of the Paris Academy of Sciences. He was elected an honorary fellow of the Chemical Society in 1908 and a foreign member of the Royal Society in 1911; in 1893 both he and van 't Hoff became Davy medallists of the Royal Society. W. J. Pope.

News and Views.

Prof. F. O. Bower, whose presidential address to the British Association is printed in our Supplement this week, is an outstanding figure in British botany. Following a brief period as lecturer in botany at the Imperial College of Science, South Kensington, he became Regius professor of botany in Glasgow in 1885, and there during his forty years of tenure of his chair devoted himself with boundless energy to the study of problems of plant morphology and affinity. His influence as a teacher, investigator, and administrator has been marked, and it may truly be said that he has done more than any other living botanist to form botanical opinion and stimulate research in his field of special inquiry. As a writer he has shown rare gifts of both analysis and synthesis. He is the author of many publications which have been widely read and constantly admired, both for their clarity of expression and constructive reasoning. Chief among these are "The Origin of a Land Flora", published in 1908, and his works on the "Ferns", published since 1923; but he has also devoted himself to more popular exposition in such works as "The Botany of the Living Plant" and "Plants and Man". He has held the presidential chair of the Royal Society of Edinburgh, has thrice been president of the Botanical Section of the British Association, and among the numerous other distinctions which have fallen to him in recognition of his work are a Royal Medal of the Royal Society, the Linnean Medal of the Linnean Society, and the Neill Prize of the Royal Society of Edinburgh.

To one so deeply interested as Prof. Bower in both the details of morphological study and broad philosophical discussion, the choice of subject for his presidential address to the British Association at Bristol may have been easy, and in choosing as his theme "Size and Form in Plants" he has presented a topic which has for long claimed his attention. Starting with Darwin's view of life that from simple beginnings creatures of endless form and beauty have been, and are being, evolved, he touches lightly on a probable common origin of the kingdoms of plants and animals, their early divergence in descent, their increasing size and complexity, and the attainment of those varied forms of colonial life which we call the higher creatures. If the offspring fail to separate, colonial life is begun and the surfaces of interaction with the outer world are restricted; growth of the dual partners proceeds to its limits, and division, without separation of the offspring, follows. Thus step by step the stature of the colony increases, the problems of life change for the individual components, and reflect themselves in the variously differentiated tissues which they come to compose. But though many of the units may die without dividing, and thus contribute in varied ways to the services of the colony as conductive and supporting tissues, in plants there is a residue of cells, mainly massed at the growing points of stem and root, which up to the limits of size and form of the colony may continue to grow, divide, and contribute still further to the stature of the colonial being. On the other hand, it would appear that the extreme stature mechanically possible for a tree-trunk thus evolved is about 300 feet, and that this coincides approximately with the limits of height of the canopy of a tropical forest; that the members of the plant kingdom range in size between the microbe and the forest tree, and that the varied forms of colonial plants which have won success in descent have been determined in large measure by the size factor.

It is to the elaboration of this thesis that Prof. Bower's presidential address is largely devoted, and in its development the surfaces through which the physiological exchanges within the plant, and with the outer world, are maintained, are discussed. In brief, it is held that both in extent and arrangement a plan of external form and internal differentiation may be satisfactory up to a limit of colonial stature, that if the plan is maintained beyond this limit the creature fails, that throughout descent failures from this cause are manifold, and that Nature has not failed to seek and find escape from extinction for many of her creatures, as their size increased, in re-arrangement of the surfaces of physiological exchange, both internal and external. It is on this view that Prof. Bower has sought once more to direct attention to the wonders of form and structure which pass coldly to-day under the science of morphology, and to place them as reasonable and varied solutions which have been found to the problems of life in its higher forms. The address closes with a note of appeal to all who may assist in rendering the link of usefulness between pure research and application stronger, and a high appreciation of all that has within recent years been attempted and accomplished in this direction.

If one may judge from the first days of the annual meeting of the British Association now in progress at Bristol, the gathering will rank as one of the most successful in recent years. The organisation of the meeting is very complete, the reception-room being set in the commodious and beautiful Great Hall of the University and the sections all adequately housed near it. The figures of the attendance to date exceed 2500, many visitors being attracted no doubt as much by the interest of the city and its environs as by the scientific papers. As we go to press, Prof. Bower's presidential address is being delivered in the Colston Hall, which visitors to the previous meeting in 1898 may remember was dramatically burnt down two days before that meeting. The first of the citizens' lectures is being given on Sept. 4 by Sir Daniel Hall, on "Apples: the Effect of Research on Production". This subject has special local interest in view of the work of the University Agricultural Station, which was founded from the earlier Fruit and Cider Institute at Long Ashton. On the same evening the Lord Mayor is holding a reception in the Museum and Art Gallery, followed by a dance in the Victoria Rooms. Amongst other items of special interest in the programme for Thursday are the address by Prof. Abercrombie to the conference of delegates, on national parks, and also the inspection of the Henry Herbert Wills Physical Laboratory, with demonstrations to members of Section A. Visits to Messrs. Wills' tobacco factory and short tours of historic Bristol, which are taking place daily, are being well patronised. The handbook for the meeting is in magazine form, and includes articles on previous meetings of the Association at Bristol and on the development of the University, together with an illustrated account of the old and new city of Bristol.

BY the retirement on Sept. 1 of Mr. H. W. Dickinson, the senior keeper, the Science Museum, South Kensington, loses one of its best-known officers. Born at Ulverston, Lancashire, sixty years ago, Mr. Dickinson was educated at Manchester Grammar School and Owens College, and after gaining practical engineering experience in various works, in 1895 he joined the staff of the Science Museum, when it was still part of the South Kensington Museums. During his thirty-five years' service he has served under four directors, General G. R. Festing, Mr. W. I. Last, Sir Francis Ogilvie, and the present director, Sir Henry Lyons, and has been associated with all the modern developments of the Museum. As an assistant keeper and a keeper he has been responsible for the compilation of various catalogues; while as senior keeper of the engineering collections, the task fell to him of installing the important exhibits in the ground floor of the new galleries opened by the King in 1928. In addition to his ordinary duties, he has acted for sixteen years as secretary to the Advisory Council of the Science Museum, presided over by Sir Hugh Bell, and during the War was secretary to a panel of men of science set up by the Ministry of Munitions for the examination of inventions.

MR. DICKINSON'S travels have made him widely known in the United States and on the Continent. Since the formation in 1920 of the Newcomen Society, he has acted as honorary secretary, and recently he has accepted the honorary secretaryship of the Second International Congress of the History of Science and Technology, which will meet in London next June and July under the presidency of Dr. Charles Singer. He is the author of a life of Robert Fulton, and the joint author, with Mr. Rhys Jenkins, of the fine memorial volume on James Watt issued in 1919 in connexion with the Watt centenary celebrations. Though his retirement marks the end of Mr. Dickinson's official career, we are glad to know that it will not mark the cessation of his activities in furthering the study of engineering and technological history.

THE Canadian Supplement of the *British Medical Journal* of Aug. 30 contains the full text of Lord Moynihan's Lister oration delivered on the occasion of the annual meeting of the British Medical Association at Winnipeg on Aug. 29. Lord Moynihan described Lister as the greatest material benefactor the world has ever known, and as one who has saved more lives than all the wars of all the ages have thrown away. Lister created a new world for surgery by making it possible to prevent infection in new wounds and to deal more successfully than before with wound infection already established. This achievement was due to the recognition of a new principle, namely, that surgical infection was due to living microbes with their power of infinitely rapid propagation in wounds. In other words, Lister's success was due to the application to surgery of Pasteur's researches on putrefaction and fermentation, to which his attention was first directed in 1865 by Thomas Anderson, professor of chemistry at Glasgow. At first, as the result of Pasteur's influence, Lister regarded the air as the chief source of danger, and therefore made considerable use of the carbolic spray, which he afterwards discarded; but he afterwards convinced himself that the surgeon's fingers and instruments were more to be feared than the air. In spite of the scepticism, ridicule, and indifference of many eminent contemporary surgeons, Lister succeeded in reducing almost to zero the incidence of erysipelas, pyæmia, hospital gangrene, and tetanus, which had hitherto been rife in the Glasgow Infirmary as in other large hospitals, and in undertaking successfully operations which had hitherto been regarded as too dangerous. In conclusion, Lord Moynihan attributes Lister's ultimate triumph not so much to his supreme intellectual gifts as to his idealism, enthusiasm, earnestness, and courage.

DR. ALEŠ HRDLIČKA has recently returned to Washington from Alaska, where he has spent the spring and early summer in investigating the ethnology of the Eskimo of Kuskokwim River. According to a report circulated by Science Service of Washington, D.C., Dr. Hrdlička found that the Eskimo in this area now number about three thousand. They had not previously been studied on the spot, and he was fortunate enough to be able to measure a considerable number of them. He also unearthed a number of very ancient burials, and by measuring the skeletal remains was able to establish their physical characters over a considerable period, possibly some hundreds of years. The results show that the type has remained constant for a long period of time, and Dr. Hrdlička concludes, it is stated, that it represents the old original type of Eskimo from which other types have developed. The distinctive feature in this type is that it lacks the extraordinary facial development and outstanding jaws characteristic of the Eskimo of Greenland and other Arctic regions. The differentiation is so marked, especially in the older specimens, as to warrant, in Dr. Hrdlička's view, the conclusion that the original type was Indian and to set definitely at rest any question that the Eskimo are of a different and distinct race. No doubt more will be heard of this matter at the International Congress of Americanists which meets at Hamburg on Sept. 7–13.

AN article by the special correspondent of the *Times* in the issue of Aug. 30 gives an account of some of the results obtained by Prof. Siegfried Loeschke on a site in Roman Trier on the Moselle. The site in question, which lies outside the original walls of the city founded by Augustus in the Altbachtal, was discovered by Prof. Loeschke in 1924. The excavations were begun in the following year and continued until Aug. 9 last, when they were closed down owing to economic difficulties. They have produced some remarkable results, especially in their bearing upon the religious beliefs and culture of the pagan Treveri, of whom little was known previously. In fact, these excavations have been pronounced by German authorities to be the most important for many years in the sphere of Romano-German cultural development and in the additions they have made to knowledge of theistic cults on Celtic soil. No less than twenty-four temples and twenty-nine chapels have been discovered in the course of these excavations. Among the more interesting finds during the current season is a life-sized marble statue of the goddess Arduinna, from whom the Ardennes takes its name ; this statue is pronounced to be the finest marble found at Trier since 1845. Another is a representation in baked clay of the Celtic goddess of the woods and waters, Artio, in the form of a bull with forelegs arched over the figure of a youth. This is headless, but otherwise complete with pediment. A number of representations of other deities have been discovered, some of which are still unidentified; but in 1928 among a hundred clay statuettes found in a building adjoining a temple were a number unquestionably intended to represent the Germanic deities, Wodan, Ziu, and Donar, which were equated with the Roman deities, Jupiter, Mars, and Hercules. This find confirms, in Prof. Loeschke's view, the statement of Roman writers that the Germanic tribes worshipped Hercules, though the Gauls left no such tradition.

FROM the publication of some of the particulars of the will of the late Miss Sarah Priestley Wainwright, a great-granddaughter of the eminent natural philosopher Joseph Priestley, we learn that the diploma and seal in box sent to him by the Empress Catherine of Russia, together with his Copley Medal, have been bequeathed to the Royal Society. This medal was awarded to him in 1773 for his "Experiments on different kinds of Air", read to the Society two years before he announced the discovery of oxygen. But from an interesting letter from Franklin to Canton, reprinted in Weld's "History of the Royal Society", 1848, it will be seen that it had been proposed to award him the medal in 1767 for his experiments in electricity. When making the presentation in 1773, Sir John Pringle, the president, said to Priestley : "In the name and by the authority of the Royal Society of London, instituted for the improvement of Natural Knowledge, I present you with this medal, the palm and laurel of this community, as a faithful and unfading testimony of their regard, and of the just sense they have of your merit, and of the persevering industry with which you have promoted the views, and thereby the honour of the Society. And in their behalf, I must earnestly request you to continue those liberal and valuable inquiries, whether by prosecuting this subject, probably not yet exhausted, or by investigating the nature of other subtill fluids of the universe." Shortly after being awarded the medal, Priestley was elected one of the eight foreign associates of the Paris Academy of Sciences.

As broadcast receiving sets with outside aerials are much used in Great Britain, the following account of what happened when the aerial of a house in Doncaster was struck by lightning will be of interest. It is probable that some one had forgotten to earth the aerial after using the set. A report of the damage done (with a diagram) is given in the *Electrical Times* for Aug. 28. The house was on high ground, somewhat exposed, and was near the middle of a long row of houses. The horizontal aerial wire was attached to the top of a 38-foot pole through an insulator and to a short pole on a chimney-stack on the roof. It then went downwards to two iron brackets and insulators which kept it away from the building. Finally it entered a room on the ground floor through a leading-in tube and was attached to the receiving set. The lightning flash seems to have struck the horizontal part of the aerial and branched in each direction. The insulator at the pole end was smashed and the aerial fell. In the other direction, the lightning seems to have sideflashed down the outside of the chimney-stack, as the lead on the roof was pulled up some six inches round the base of the stack. The insulator on the top bracket was smashed, a charge sideflashing through it into a wall of lath and plaster separating two rooms, apparently bursting the wall and scattering plaster into each room. The insulator of the lower bracket was unbroken, a charge arcing to the bricks and scattering portions of them a distance of about thirty feet. The rest of the charge entered the receiving set and burst a condenser in it. On raising the lid, it looked as if everything had been sprayed over with pitch, doubtless from the condenser; but no damage was done to the valves or the transformers. The house fuses for the electric-lighting mains were blown and three electric lamps had their filaments broken, but the insulation of the mains was undamaged. Most sets with outside aerials have lightning protectors. It is advisable, therefore, to see that they are switched on during a thunderstorm.

"THE present centrifugal movement towards specialisation with its resultant divergency of interests and tendency to misunderstanding between workers" was deplored by Mr. C. E. Andrews, Government Geologist in New South Wales, in his recent presidential address to the Australian and New Zealand Association for the Advancement of Science. He commended the suggestion once made by Gilbert, the philosopher-geologist of America, who advocated "the extensive use of the 'Intellectual Excursion' amongst workers", meaning thereby that they should take an intelligent interest in work going on in other fields besides their own. Such excursions may prove a fruitful source of inspiration, an instance of which was given by Mr. Andrews in Darwin's utilisation in the "Origin of Species" of Mathew's work on "Naval Timber". He might also have added that perhaps Darwin's masterpiece would never have been written had not the author perused Malthus's "Essay on Population". But altogether apart from the stimulating effect of occasional excursions into other fields, there is the enlargement of the mind which accompanies the 'synoptic' point of view. Men of science have sometimes been charged with Philistinism, and specialism may easily tend in this direction. The best antidote would be that every student should work out some sort of a philosophical outlook for himself; but this he will scarcely do if he is blind to the importance of every subject except his own.

THE University of London Animal Welfare Society has sent us a letter appealing for information about the condition under which badgers and otters exist to-day in Britain. These are elusive animals and their secretive and nocturnal habits must make the collecting of accurate information about their distribution and numbers wellnigh impossible, but a present-day census, even if incomplete, would give a kind of standard by which fluctuations in future years might be tested. Helpers in this good work are requested to answer a series of questions with the view of elucidating: (*a*) The localities now inhabited by badgers and otters, their numbers and the years of special abundance or scarcity, the nature of their habitats, and natural causes of death; (*b*) their habits, especially in regard to their economic relations to the farm, game-preserving, and fishing; (*c*) methods of trapping and their desirability or otherwise from the point of view of cruelty involved, the nature of the 'sport' the creatures are subject to, and whether it is desirable as an effective means of destruction. Replies to the queries, which have been stated above in summary, should be sent to Miss Ada Hallett, 34 Acre Lane, London, S.W.2.

DR. JOHN WALTON, lecturer in botany in the University of Manchester, who has been appointed to the Regius professorship of botany in the University of Glasgow (NATURE, Aug. 30, p. 332), is well known as a distinguished authority upon fossil plants, particularly those of the Carboniferous system, and his appointment to the University of Glasgow seems particularly appropriate in view of the fact that the department of botany in that University houses the great Kidston collection of fossil plants with its accompanying library. The new professor may be expected to carry on the morphological traditions of the Glasgow school associated particularly with the name of Prof. F. O. Bower.

DR. J. A. CARROLL, assistant director of the Solar Physics Observatory, Cambridge, has been appointed professor of natural philosophy in the University of Aberdeen in succession to Prof. G. P. Thomson. Dr. Leslie J. Comrie, deputy superintendent since 1925 of the Nautical Almanac Office, has been appointed superintendent of the office in succession to Dr. P. H. Cowell, who has retired under the age limit after twenty years' service.

WE have received vol. 12 (1929) of Experimental Researches and Reports published by the Department of Glass Technology, University of Sheffield. This contains reprints of a number of papers published from the department in different journals covering various sides of the industry.

THE U.S. Coast and Geodetic Survey publication entitled "Directions for Magnetic Measurements", by Daniel L. Hazard, was reprinted in 1921, and a further (third) edition (serial number 166, price 30 cents) has now been issued. It gives the theory of magnetic instruments, and directions for their use on land and at sea. The principal instruments considered are the ordinary magnetometer, the dip circle, and the dip inductor; in further editions some account of electrical means of measuring the magnetic force may be hoped for. Brief instructions as to the operation of a magnetic observatory are included, but a separate detailed manual on that subject is in preparation. There is also a brief chapter on earthquakes and seismographs. The manual is a very valuable and inexpensive short treatise on practical magnetic work.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant road engineer in the Roads Department of Southern Rhodesia—The High Commissioner for Southern Rhodesia, Crown House, Aldwych, W.C.2 (Sept. 7). An instructor in veterinary science under the Glamorgan Agricultural Committee—The Director of Agriculture, 17 Park Place, Cardiff (Sept. 8). A veterinary surgeon under the Municipal Commissioners of George Town, Penang—Peirce and Williams, 1 Victoria Street, S.W.1 (Sept. 9). A half-time assistant in the Geology Department of the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (Sept. 12). A demonstrator in chemical pathology in the University of Manchester—The Registrar, University, Manchester (Sept. 13). A junior lecturer and demonstrator in the chemical department of East London College—The Registrar, East London College, Mile End Road, E.1 (Sept. 13). A research officer for investigations of fisheries, Andaman Islands—The Secretary to the High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Sept. 17). A senior factory inspector under the Ministry of Labour of the Government of Northern Ireland—The Secretary, Civil Service Commission, 15 Donegall Square West, Belfast (Sept.

20). An assistant lecturer in chemistry in the University of Birmingham—The Secretary, University, Edmund Street, Birmingham (Sept. 20). An assistant part-time lecturer in the biology department of the Plymouth and Devonport Technical College—The Secretary for Education, Education Office, Plymouth (Sept. 20). A lecturer in botany at the Sunderland Technical College—The Chief Education Officer, Education Offices, 15 John Street, Sunderland (Sept. 22). Civilian education officers with a degree in engineering, in the R.A.F. Educational Service—The Secretary, Air Ministry, Gwydyr House, Whitehall, S.W.1 (Sept. 22). An assistant lecturer in mathematics at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (Sept. 24). An agricultural mycologist at the Agricultural Institute and Experimental Station, Kirton, Lincs—The Principal, Agricultural Institute, Kirton, near Boston, Lincs (Sept. 27). A senior lecturer in education in the University of Liverpool—The Registrar, The University, Liverpool (Sept. 30). A lecturer in chemistry in the Egyptian University, Cairo—The Dean of the Faculty of Science, Egyptian University, Abbassia, Cairo (Oct. 14). A professor of pathology at the Medical College, Vizagapatam, Madras—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Nov. 3).

ERRATUM.—NATURE of Aug. 23, p. 272, col. 2, line 19, for " west to east " read " east to west ".

Our Astronomical Column.

Meteoric Theory of the Lunar Craters.—*Scientia* for August contains a paper by A. C. Gifford in which he supports the meteoric origin of the lunar craters and walled plains, as against the volcanic theory. He refers to Meteor Crater in Arizona, and the gigantic Siberian meteor of June 30, 1908, as evidence that large meteoric masses still traverse the solar system ; he assumes that they were much more numerous in the early days of the planetary system, since he adopts the planetesimal theory in preference to the gaseous filament theory proposed by Jeans and Jeffreys.

The objection that oblique impacts would not produce circular craters is answered by the assertion that the crater is not due to the impact itself, but to the explosion resulting from the violent heat produced by the sudden stoppage of the meteor. Mr. Gifford claims that the greater part of the matter scattered by the explosion would be driven out horizontally, forming the wall of the crater, while the matter that was thrown upwards would, on its descent, form the central peak or peaks. The explosion would reduce the material to fine powder, thus explaining the whiteness of many of the craters ; it is noted that black glass appears white when finely powdered. Such matter as was reduced to a molten state by the impact would on solidification produce a dark surface, like that seen in the interior of Plato and other craters. The systems of radiating bright streaks surrounding Tycho, Copernicus, etc., are explained by supposing that in these cases the meteoric impact cracked the lunar crust, and molten matter was driven through the cracks from the interior, afterwards solidifying in a crystalline form.

Mr. Gifford compares his theory with that put forward in 1903 by Prof. N. S. Shaler. The latter also postulated the impact of large meteoric masses on the moon, but did not adopt the view that a great explosion would result from the sudden stoppage of the meteor and its reduction to a gaseous form ; he supposed that the lunar surface would be liquefied and produce an extensive level region of a dark colour. In other words, he ascribed the *maria*, not the craters, to meteoric impact.

The Radcliffe Observatory and South Africa.—Mr. F. Robbins, the treasurer of the British Astronomical Association, has contributed two articles to the *Journal* of that body (vol. 40, Nos. 7 and 8) in which he describes the present general recognition of the value of South Africa as a centre for astronomical observation. This was pointed out by La Caille nearly two centuries ago ; later on, Fallows and Sir John Herschel gave similar testimony. In the present century, Dr. Innes has spoken so enthusiastically of the climate of Johannesburg that astronomers from the United States, Leyden, and Berlin are establishing observatories in that region. The second article deals with the Radcliffe Observatory, the removal of which to Pretoria is now contemplated. John Radcliffe was a celebrated physician who died in 1714 at the age of sixty-one years. He left a large sum to be expended in Oxford. This is partly represented by the Library in the Radcliffe Camera. The remainder was devoted in 1770 to the building and endowment of the Radcliffe Observatory. The observations made by Dr. Hornsby, the first observer there, have not yet been fully reduced, but this is now being done by Dr. Knox Shaw. Mr. Robbins's article summarises the work done at the Observatory since its foundation, and includes eight reproductions of illustrations of the building and instruments.

Slitless Spectrograms of the Orion Nebula.—In a recent communication to the Royal Astronomical Society (*Mon. Not.*, **90**, p. 580), Dr. W. J. S. Lockyer publishes some slitless spectrograms of the Orion nebula, extending from the green 'nebulium' lines to the pair at $\lambda 3727$, obtained with much higher dispersion than has been previously used for this work. The results are discussed in relation to earlier work of the same kind by Pickering and Mitchell and to the researches of Keeler, Hartmann, and Reynolds, who photographed monochromatic images, using specially prepared light-filters. The results endorse in the main those of the investigators named, and show that the radiation from the central portion of the nebula—the so-called Huyghenian region—is almost entirely due to hydrogen, and the two 'nebulium' lines, N_{12}, now traced to O III. The 'Messierian' branch, to the east of the central portion, emits this radiation together with the $\lambda 3727$ pair of O II, and the outlying regions radiate the $\lambda 3727$ pair with practically nothing else. Numerical estimates are given, on an arbitrary scale, of the intensities of each of the several radiations in different regions. The relative faintness of the $\lambda 3727$ images compared with those obtained by other workers—Reynolds, for example—is doubtless attributable to absorption in the lenses of the telescope; Reynolds, who obtained much stronger images, used a reflector. On p. 523 of the same volume of the *Monthly Notices* appears another communication from the Norman Lockyer Observatory—a further list of spectroscopic parallaxes and spectral types of *B*-type stars determined by Mr. D. L. Edwards. Data for 175 stars are tabulated and discussed in comparison with the results of other observers, with which they agree very well.

Research Items.

Medieval Indian Dress.—Mr. K. de B. Codrington contributes to the *Indian Antiquary* for August the first instalment of a study of medieval Indian culture as illustrated in the frescoes of the Ajanta Caves. The style of the frescoes, though mannered, is based on a minute observation of life; and there is no reason to doubt that the textiles, arms, and accoutrements are a faithful witness to vanished originals, except in the case of the frescoes of Buddha, of which the piled-up head-dresses and the jewelled necklaces never existed outside the tradition. With regard to chronology, four, or at most five, sequence styles can be detected, and the work is of the sixth and perhaps part of the seventh century, but certainly not later. Mr. Codrington here deals with costume and embroidery and textiles. It is usually said that cut and sewed garments were unknown in ancient India. Though this is borne out by the early sculpture at Bharhut and Sanchi, it does not apply to Ajanta. The indoor costume of the women consisted of a waist-cloth of varying length, usually supported by a beaded or jewelled belt. Occasionally a breast-cloth or scarf is worn. On other occasions a knee-length garment was worn, apparently slipped over the head, fitting tightly on the shoulders, and opening up on either side. With it was worn a long-sleeved waist-length bodice. The waist-cloth is the chief costume of the men, though the hunters and other forest people wear the small loin-cloth. A long-sleeved tunic to the knee is worn by soldiers and horsemen. Another type of jacket had short sleeves and ended at the waist. There are embroideries at the wrists, upper arm, and neck, and sometimes down the front. In some cases the dress seems to be a uniform. Here a waist-cloth is worn, but princes and heroes wear *paijamas* or tight-fitting 'jodhpurs'. With these one prince wears scarlet leather slippers.

Arterial System of Lemurs.—One of the most interesting results of the investigation of the anatomy of *Loris lyddekerianus* by Drs. A. Subba Rau and P. Krishna Rao (*Half-yearly Jour.*, Mysore University, vol. 4, p. 90, 1930) is the detailed description of a plexiform condition of the subclavian, external iliac, and middle sacral arteries. This leads to a general discussion of the purposes served by arterial plexuses, which, although most often found in aquatic air-breathing animals, are not confined to these and reveal no phylogenetic relationship or indeed at first sight any similarity of habit in their possessors. This is evident from their occurrence in creatures of such different modes of life as fishes, birds, and amongst mammals, ungulates, cetaceans, and lemurs. Various suggestions have been made as to the significance of the plexuses, such as that they merely represent a persistence of the embryonic phase of the arterial system, or that the minute branches diminished the velocity of the blood stream to the muscles, or that they served to maintain normal circulation during the period of contraction of the muscles. Judging from the structure and position of the plexuses in *Loris*, and from the association of venous with arterial plexuses, the authors "reaffirm the proposition already hinted at by Caralisle and add confirmative evidence in support of the view of Burne that these plexuses serve as storage tanks for arterial blood", and that they "regulate the supply of blood to the limbs in the same way as the spleen functions in regulating the blood supply to the viscera".

Aalborg Herring.—The Report of the Danish Biological Station to the Ministry of Shipping and Fisheries, 35; 1929, by the Director, Dr. A. C. Johansen, contains some very interesting work. In the first part, "The Aalborg Herring and its Importance to the Danish Herring Fishery from the XVIth Century until the Present Day", Dr. Johansen deals with the history of the Limfjord herring fishery. In early years the Aalborg herring was the only one in the Limfjord, coming in from the Kattegat to spawn, but the breaking through of the Agger Isthmus in 1825 and the consequent inflow of salt water from the North Sea influenced the fishery profoundly. Not only was there an immigration of fish of different races from the west but also the altered conditions of salinity affected the spawning grounds of the original herring. There is distinct evidence to show that the eastern herring of the Limfjord of the present day is the descendant of the original Aalborg herring, having the same habits. Together with those of other races from different parts, it almost certainly spends part of its life in the Skagerrak feeding on the abundant and rich plankton to be found there, which fact accounts for its quality and its importance for centuries in the Danish fishery. The present day herring fishery, although proportionally not so large as in early years, is in a flourishing condition and the last decades show a decided increase, partly owing to the use made of the young, known as 'silding'.

Plankton of British Columbia.—Mr. G. H. Wailes has been occupying himself for some years with the marine plankton of British Columbia, publishing from time to time his very useful summaries of the various groups in the *Vancouver Museum and Art Notes*. The present paper, "Marine Zoo-Plankton of British Columbia" is reprinted from Vol. 4, 1929, of that publication, and embodies an address given to the Burrard Field Naturalists' Club on Oct. 25, 1929. The chief interest of this plankton lies in the fact that many forms are common to the Pacific and Atlantic and a plankton haul from Vancouver does not look very different from one from British seas. Some species are certainly different, but many may be closely related, such as *Calanus tonsus*, which to a large extent replaces *Calanus finmarchicus* in the Strait of Georgia. In the list of Copepoda are to be noted as abundant such common British species as *Calanus finmarchicus*, *Pseudocalanus elongatus*, *Metridia lucens*, and *Anomalocera pattersoni*, and similarly in other groups one meets many species which are familiar. A table is drawn up to show the food chains in the sea with special reference to *Clupea pallasi*, the Pacific herring, and the sock-eye salmon, *Oncorhynchus nerka*, including the various enemies of the latter fish.

Northern Echinoderms.—Two papers in *Bergens Museums Arbok* for 1929 deal with echinoderms. The first, by Mr. James A. Grieg, "Some Echinoderms from the South Shetlands" (Naturvidenskapelig rekke No. 3), describes some interesting collections from the Whaling Station in Admiralty Bay and from two of the whaling boats probably taken near the same locality. Among the sixteen species recorded there are some which are very little known and have only rarely been seen, and some which hitherto were only recorded from the Antarctic regions. In the second paper (No. 9) Mr. Sven Runnström describes a new spatangid larva from the west coast of Norway. These occurred between 50 and 100 metres, only four being found, representing a series of developing stages. The youngest larva still contained a good deal of yolk, showing that it must have come from a yolk-laden egg. Red-gold yolky eggs were also collected which probably belonged to the same species. The author suggests that the eggs and larvæ are those of *Briaster fragilis*, the development of which was unknown but whose yolky eggs led Dr. Mortensen to predict direct development.

Mollusca from the Raised Beach at Portland Bill.—Collections have from time to time been made of the molluscan remains occurring in the raised beach at Portland Bill by such well-known observers as Pengelly, Prestwich, Damon, and Sykes, as well as by the Geological Survey, but so far no list has been given including the results of all their published observations. This has now been done by Mr. D. F. W. Baden-Powell (*Proc. Malac. Soc. Lond.*, Vol. 19), who has further added to the number of species found, which thus amounts to more than fifty, and supplied notes concerning each. With one possible exception, none of the forms is extinct, and the lower limit of age of the deposit may therefore be placed in the Pleistocene, and perhaps rather after the middle thereof, rather than in the Pliocene. The assemblage represents a more northern one than that now found at Portland, and the suggestion is that the sea at the time of the formation of this raised beach was colder than at present.

Temperature Gradients in the Permian of Texas.—W. B. Lang has discussed the depressed isogeothermal surfaces of the Permian Basin of Western Texas (*Jour. Wash. Acad. Sci.*, April 4, 1930). A well was recently drilled 4400 feet through Permian formations carrying anhydrite, into Carboniferous and Pre-Cambrian rocks. The subnormal gradient characteristic of the Basin was met with until the anhydrite beds were passed through, after which the gradient rapidly steepened. It therefore appears that internal heat is being conducted more rapidly by the anhydrite than by the underlying sediments. The thermal conductivities of anhydrite and rock salt are respectively 0·0123 and 0·0137, values twice as high as those characteristic of ordinary sediments. It is pointed out that our present data on the thermal conductivities of rocks as they exist under natural conditions are very meagre. The effects of compaction, porosity, bedding, mineral orientation, degree of cementation and water content have rarely been considered, although when cumulative they may be very great. There is urgent need for research on these lines, for until better data are forthcoming geothermal problems cannot be attacked with precision.

Copper Belt of Northern Rhodesia.—The new copper field of Northern Rhodesia gives promise of becoming the greatest copper-mining centre of the world, for already the ore-reserves have been estimated at between 500 and 1000 million tons of copper. A detailed account by Alan M. Bateman of the deposits and their geological setting and origin appears in *Economic Geology*, June–July, 1930, pp. 365-418. The rocks of the area consist of an old basal complex overlain unconformably by the ore-containing Roan Series. The latter are continental sediments cut and metamorphosed by granite intrusions that represent the magmatic source of the copper. The areal distribution of the granite along the copper belt suggests a slightly eroded batholith with pendants of sediments projecting deeply into the granite. The pitchblende of Katanga has been shown by its lead ratio to be of late Pre-Cambrian age, and since the copper sulphides of Rhodesia and Katanga evidently belong to one metallogenic epoch, the Roan Series must therefore almost certainly be of Pre-Cambrian age. The sediments have been folded into open pitching folds with a north-westerly trend, giving V-shaped outcrops. The ore-beds are disseminations of minute specks of copper sulphides with sparse but deep oxidation in all the mines. The paragenesis is pyrite, linnæite, chalcopyrite, chalcopyrite and bornite, bornite, bornite and hypogene chalcocite, hypogene chalcocite, supergene chalcocite, and oxidation products. The latter probably formed at great depths during a former period of desert climate.

Wireless Echoes.—The address given by Prof. Carl Størmer to the Royal Society of Edinburgh on Feb. 17 has now been published in the Society's *Proceedings* (vol. 50, p. 187). He discusses the problem of whether the 'wireless echoes of long delay' come from space outside the moon's orbit or not. In a communication to NATURE of Jan. 5, 1929, he said: "the mathematical theory of the motion of electric corpuscles around a magnetised sphere shows that the chances of obtaining a well-defined toroidal space round the earth are good when the direction to the sun lies near the magnetic equatorial plane (perpendicular to the magnetic axis)." He predicted that it was very improbable that echoes would recur before the middle of February. This prediction was duly verified by several physicists. In particular, two observers in Indo-China observed two thousand echoes from a relatively small emitter station. The echoes came about 30 sec. after the signal and their amplitude was sometimes as great as one-third of the signal. Some of the experiments recorded prove conclusively that they were echoes. It seems as if the space outside the earth's orbit was traversed intermittently by very unstable streams of electrons. This may explain the great variety of echo times observed. It is also possible that multiple echoes may be caused by reflection between the inner walls of the toroidal space. The great variety of echoes is similar to the great variations in aurora phenomena and magnetic perturbations. If this explanation is correct, these wireless echoes give a striking proof of the corpuscular theory of aurora and a valuable method for exploring electron currents in cosmic space.

X-ray Wave-lengths and the Electronic Charge.—The determination of an X-ray wave-length by means of a ruled grating, in correlating quantities of atomic and of macroscopic dimensions, leads indirectly to an evaluation of the charge (e) on an electron, and, as is well known, the value of e obtained by this method is slightly larger than that found by the oil-drop method of Prof. Millikan. Further evidence for the reality of this discrepancy is furnished by some measurements of the wave-lengths of the L lines of molybdenum, of which an account is given by J. M. Cork in the second June issue of the *Physical Review*. The gratings used were of glass, ruled with either 30,000 or 14,400 lines to the inch, and were mounted in a vacuum spectrograph in direct connexion with a hot-filament X-ray tube. The values obtained for the wave-lengths of the $L\alpha_1$ and $L\beta_1$ lines were 5·4116 A. and 5·1832 A. respectively, whereas it was calculated on the basis of Prof. Siegbahn's measurements with a gypsum crystal that if calcite had been employed and corrections made for refraction, the two numbers would have been 5·3960 A. and 5·1674 A. The corresponding value for e is $4 \cdot 8162 \times 10^{-10}$ e.s.u., which is slightly larger than the number given by J. A. Bearden as a result of similar measurements with the K radiation of copper.

Cleavage Tests of Timber.—One of the tests made in connexion with the anisotropic properties of timber is a determination of its resistance to cleavage by the application of equal and opposite loads, up to fracture, along the diameters of incomplete holes bored in flat specimens cut so that the stress is normal to the direction of the grain. An investigation by the photo-elastic method of the stresses which are set up, with the obvious limitation that the models used are isotropic, is described by Prof. E. G. Coker and G. P. Coleman in the *Proceedings of the Royal Society* for August. It has been found that the stresses are decidedly complex, and, moreover, that each form of test piece gives rise to a stress distribution peculiar to itself, which is doubtless further complicated in practice by the anisotropy, so that fairly comparable results in actual tests can only be expected when one form is adhered to. It is suggested, however, that it would probably be better to rely on a simple tension test to define cleavage property, with an arrangement so that load is applied uniformly and normally to the grain of the timber; such a test would, in a short length, exert normal tension across a large number of cells, and its selective action would ensure fracture at the weakest place.

Earthing Resistances.—The necessity of earthing electrical supply networks at one or more points has led engineers to study very carefully the best method of securing a good earthing electrode. In some cases a network of water pipes, the lead sheath of a large sized cable, or the steel structure of a building is available, but in many cases pipes, plates, and strips buried in the earth have to be used and it is advisable to know their relative merits. In a paper in the June number of the *Journal of the Institution of Electrical Engineers*, P. J. Higgs, of the National Physical Laboratory, gives a helpful account, both theoretical and experimental, of various kinds of earthing resistances. He bègins by investigating the phenomena of polarisation and endosmose which happen when electric currents flow through damp earth and points out that their effects are very appreciable. Pipes, plates, and strips were installed in a plot of ground near the laboratory and periodic tests of their earth resistance were made for a year. The results obtained are of practical utility, but it is difficult to deduce general conclusions from them as the ground was probably far from being homogeneous. The seasonal variations in resistance during the year were found to depend on moisture and temperature, the former being the more important. The possible differences between measurements made with alternating and direct currents were also investigated. It was found that the resistances with direct current were greater than with alternating current, the maximum difference being about twenty per cent. The experiments indicate that pipes are the best to use. It was found that two pipes spaced about five feet apart and connected in parallel make a much more efficient earth than one pipe of diameter equal to the sum of the two.

Reactivity of Hot Coke.—It is known that the 'reactivity' or readiness with which a red-hot coke will reduce carbon dioxide is much increased by the presence of compounds of iron, and this 'reactivity' is liable to curious fluctuations with varying conditions. A study of this influence of iron compounds on the reactivity of coke forms the subject of a report by J. H. Jones, J. G. King, and F. S. Sinnatt (Fuel Research Technical Paper No. 25, H.M.S.O., 9*d.* net.) They show that the activating effect of metallic iron is large, of ferrous oxide small, and the fluctuations in activity are determined by the presence of iron in the reduced or reducible form. Should the iron be converted into non-reducible forms such as silicate or sulphide, the coke becomes relatively inert, although in the latter case reactivation may be brought about by exposure to air. Although other inorganic ingredients are known to increase the reactivity of cokes, it is concluded that in metallurgical cokes the preponderating catalytic effect is to be ascribed to the iron present.

Evolution of Heat by Polonium.—An interesting paper on this subject is published in the current issue of *Roczniki Chemji*, the organ of the Polish Chemical Society (**10**, 304-313; 1930), by Mlle. Alicja Dorabialska. The investigation was carried out in the Curie Radium Institute, Paris. The evolution of heat was measured by means of the adiabatic microcalorimeter constructed by Prof. Swietoslawski and Mlle. Dorabialska, made of different metals (copper, aluminium, zinc, nickel) and weighing only 2·3·5 gm. The experiments were made with three extremely small quantities of polonium, possessing an energy of about 3000 e.s.u. and weighing about 0·0005 gm., which were deposited one on a silver leaf, another on a nickel leaf, while a third was sealed in a copper tube filled with nitrogen. The rise of temperature amounted to 0·150°-0·250° per hour. The mean value obtained in the three series of experiments (nine in number) was $1 \cdot 87 \times 10^{-5}(\pm 0 \cdot 9$ p.c.) cal. per hour and per one electrostatic unit of polonium. From this number may be calculated the evolution of heat by one curie of polonium as 24·2 cal./hour. The number of α-particles calculated from this value would be equal to $3 \cdot 4 \times 10^{10}$ per second either by one curie of polonium or by one gram of radium (Geiger and Werner find for this value $3 \cdot 4 \times 10^{10}$). It is interesting to note that one gram of polonium would evolve $1 \cdot 1 \times 10^5$ cal./hour, and one gram-atom of polonium would evolve during its life-time (197 days) $1 \cdot 1 \times 10^{11}$ cal. (one hundred thousand million calories).

Sensitising and Desensitising Dyes of the Cyanine and Related Types.—A little more than two years ago (*Phot. Jour.*, 21; 1928) Mr. Olaf Bloch and Dr. Frances M. Hamer of the Research Laboratories of Ilford, Limited and of British Photographic Plates and Papers, Limited, published their first paper on the optical and photographic properties of these compounds, dealing with a complete series of typical, simple, cyanine dyes. They now (*Phot. Jour.*, 374; 1930) deal with 8 cyanine dyes, 12 styryl compounds, 2 cinnamylidene derivatives, and 10 anyls. Six of the cyanine dyes have recently been prepared for the first time by one of the authors. All were examined under the same conditions as described in the previous communication. Some of the compounds are sensitisers while others are desensitisers, but the change of structure which occasions this change of function is a comparatively slight one. The photographic action of dyes can show "enormous variations" with variations in the character and treatment of the emulsions employed in testing them, so that generalisations are at present impossible. The authors give the structural formulæ, names, spectrum absorption curves, sensitising curves, various physical properties, and certain analytical results of the dyes dealt with. During the discussion, Dr. Walter Clark suggested that it would be more reasonable to measure the absorption curve of the silver bromide dye complex rather than that of the dye itself, and Mr. Bloch said that it had been tried. He also asked if the authors had found any relation between the absorption spectrum of the desensitiser and the wave-length desensitisation due to it. Miss Hamer replied that there is no relation; there are numerous colourless desensitisers.

Denaturation of Proteins by Urea and Related Substances.*

By Sir F. GOWLAND HOPKINS, F.R.S.

UPON the facts enumerated the following simple method of determining the degree and rate of denaturation is based. A measured sample of the urea-protein mixture is diluted with ten times its bulk of water, and to secure complete precipitation of the denatured product a small quantity (say 1 gm. per 100 c.c.) of ammonium sulphate is added, and if precipitation is not immediate a small amount of acetic acid. When the precipitate has settled out it is filtered and washed, or better centrifuged and washed, until free from sulphate, when it will also be free from undenatured protein. The precipitate is then transferred to a tared basin, dried and weighed. The method is trustworthy and gives consistent results. If the protein left in solution after the precipitate has been removed be thrown out by saturation with ammonium sulphate, it will be found to be wholly resoluble in water; that is to say, it is undenatured albumin.

The rate of denaturation increases with increasing concentration of urea. With respect to the influence of protein concentration but few determinations have been made, but it may be said that within a fairly wide range of concentration the percentage denatured in a given time by a particular concentration of urea remains of the same order.

The only quantitative results which will be given here are those which bear upon the effect of temperature upon the process. These have special interest. In the experiments carried out to determine the rate of change, solutions containing about 5 per cent of protein have been employed and the urea added to 60 per cent of full saturation (of saturation, that is, at 15° C.; 0·6 gm. added per c.c.). With such proportions, while denaturation is rapid, there is for relatively long periods no spontaneous separation of the product, either as precipitate or gel.

The following results of two experiments are fully representative of many. After the addition of urea the solutions stood at the temperatures mentioned, and the amount of denatured protein determined at the intervals stated. It is given in percentage of the whole protein present. The concentration of albumin mentioned in the first column is that of the original solution, not that present after the increase of volume due to the addition of urea.

Experiment.	Temperature. (° C.)	Amount of Denatured Protein at Intervals after Addition of Urea (per cent of whole Protein present).		
		15 Min.	1 Hour.	3 Hours.
A. Albumin solution 5 per cent. Urea, 0·6 gm. per c.c. *p*H before dilution, 5·9	0	79·0	86·2	92·8
	23	49·2	69·2	88·5
	37	..	61·0	85·1
B. Albumin solution, 4·14 per cent. Urea, 0·6 gm. per c.c. *p*H before dilution, 6·0	0	78·3	85·7	91·0
	22	45·1	62·7	87·5
	37	..	58·1	82·8

It is seen that denaturation by urea is a rapid process at each temperature investigated. While, however, heat denaturation was shown in the classical experiments of Chick and Martin [5] to be a process with an exceptionally high temperature coefficient, the above figures present the simulacrum of a negative coefficient. At the concentrations employed nearly 80 per cent of the albumin is denatured in 15 min. at 0° C. and less than 50 per cent at 22° C. Data such as the above have been repeatedly obtained. There is no reversal of the process on any lines with increase of temperature. Denaturation in any case ultimately proceeds nearly to completion. Only such temperatures are, of course, to be considered as are well below those at which heat denaturation itself begins.

The provisional hypothesis which perhaps most readily covers such facts is that denaturation occurs in a protein-urea compound which, save in the presence of large concentrations of urea, is highly dissociated, and of which the dissociation increases with rise of temperature sufficiently to account for the observed diminution in the rate of denaturation. The increased dissociation must then be assumed to outweigh other temperature effects. Proof or disproof of such a view must depend upon a study of various equilibrium relations. This offers technical difficulties and results are not yet available.

Certain substances, which can be shown to denaturate egg albumin, differ from urea in that their solutions exert little or no dispersive action upon the denatured product. Thus, whatever the relative concentrations, when such substances are present in amounts sufficient to denaturate actively, the product separates rapidly as a precipitate. Urethane presents a case of this kind.

If a concentrated solution of urethane be gradually added to an albumin solution, a point is reached at which precipitation begins immediately. If then the mixture be allowed to stand, denaturation and separation of the product proceed rapidly, and a large proportion of the protein will be denatured in the course of a few minutes. Thus to a 5 per cent albumin solution (*p*H 4·8) urethane in strong solution was added at 20° C. Precipitation began when the mixture contained 18 per cent urethane, and in ten minutes the precipitate (a typically denatured product) was centrifuged, washed, and weighed. It amounted to 59 per cent of the original protein. Like urea, concentrated urethane acts very rapidly at 0° C. It denaturates, though more slowly, when a solution contains 10 per cent or less.

Thiourea also denaturates while displaying little dispersive power. To separate samples of 4 per cent albumin solution at *p*H 4·86 thiourea was added to saturation (9 per cent). On standing at 17° C. precipitates separated and were weighed at successive intervals. After 15 minutes about 12 per cent, after 3 hours 25·5 per cent, 24 hours 62 per cent, and after 48 hours 80 per cent of the protein proved to be denatured.

Although the effective concentrations of the denaturants under discussion is high, it is scarcely likely that a 'lyotrope' action plays any dominant part in producing their effects. The phenomena differ of course in fundamental aspects from that of 'salting out' by electrolytes.

The simultaneous presence of electrolytes in solution, though, on the whole, tending to diminish its velocity, does not seem to exercise an important influence upon denaturation by urea, at least in the case of molar concentrations which alone have been tried. It is possible that a study of their effects in higher concentrations might throw some light upon the process.

One other circumstance associated with the phenomena under discussion should be mentioned. Using the green line of the mercury vapour lamp, the optical

* Continued from p. 330.

rotation of protein solutions was found to increase (after making due correction for the resultant change of volume) more than threefold when saturated with urea. In three separate experiments the rotation was increased to 3·25, 3·45, and 3·30 times its original value in water. I refer to this here merely as a fact empirically established.

SERUM PROTEINS.

Fewer observations have been made upon these and less space must be given to their description.

Attention must first be directed to the circumstance that blood proteins, unlike egg albumin, do not when denatured by any form of treatment yield a nitroprusside reaction direct. If, however, the denatured products are afterwards exposed to reducing agents, they then give a colour reaction which is intense. The most convenient method of demonstration is to add a small quantity of potassium cyanide to the solution of denatured protein, or to soak a precipitate or gel in a 1-2 per cent solution of cyanide before, in each case, dissolving a little solid nitroprusside in the fluid. A justifiable assumption is that the precursor of the active thiol group is a disulphide grouping not present in the native protein but established on denaturation. The effects of cyanide, etc., are exactly similar to those observed in the case of cystine and its conversion into cysteine.[6]

If native serum (horse or sheep) or solutions of separated albumin and paraglobulins be saturated with urea and the mixture allowed to stand for a few minutes in the presence of a little potassium cyanide, the addition of nitroprusside solution (plus ammonia if the solution be not sufficiently alkaline) will then produce an intense colour reaction.

Serum or its separated constituents (the behaviour of euglobulins has not been studied) on evaporation with denaturants on the lines described for egg albumin, whether the *p*H be that of native serum or reduced, say, to 5, behave similarly to the latter. Substances which denaturate the one protein act upon the other: those which fail in one case fail in all.

When, however, their behaviour is observed in solution, it becomes clear that the blood proteins are definitely more resistant to denaturation on these lines than in ovalbumin. It is noteworthy that the difference is more marked when the influence of urea, itself, is in question than in the case of, say, urethane with its smaller dispersive power.

Serum in its native condition or when brought to a *p*H of the order of 5, if saturated with urea, sets in a few hours at room temperature, and somewhat more rapidly at 37° C., to a jelly, and so in strong solutions do serum albumin and globulin. Such jellies treated as described above give an intense nitroprusside reaction, but only gradually after more prolonged standing do they show the resistance to redispersion into sols, which is characteristic of ovalbumin gels. Nevertheless, diluted serum or solutions of serum albumin or paraglobulin containing, say, 4-5 per cent protein, when mixed with such concentrations of urea as will rapidly denaturate ovalbumin, yield even after several hours' standing no precipitate on dilution or dialysis, and show no signs when dialysed free from urea of having assumed the characters of the suspensoid condition. This remains true if the *p*H of the solutions before or after adding the urea is brought to near the isoelectrical point of the proteins when denaturated by heat, 5-5·4. Observations giving these results have been made with the proteins of sheep's blood and with crystallised albumin from horse serum. Only after remaining many days in contact with urea do the blood proteins show evidence of more complete denaturation. On the other hand, their solutions when mixed with high concentrations of urea give at once after treatment with cyanide an intense nitroprusside reaction. It would seem as though these proteins undergo with readiness the chemical changes which in all cases are associated with denaturation, but the colloid particles of the product are more resistant than those of egg albumin to the dehydration which characterises the change from the lyophil to the lyophobe condition.

Easily to be demonstrated, however, is the denaturation of blood proteins under the influence of urethane, especially, but not only, when they are brought near to their isoelectric point. The following figures are illustrative. Dialysed and filtered sheep serum was brought to *p*H 4·86 and urethane (0·3 gm. per c.c.) added. After 1 hour at 20° C. 22·5 per cent of the total protein was denaturated; and after 3 hours 41·0 per cent. With thrice the concentration of urethane 43·5 per cent was denaturated in 1 hour. The process is clearly much slower than in the case of ovalbumin.

It is with intention that these notes have been confined to a simple description of observations which are themselves of a preliminary kind. Points of theoretical interest can scarcely fail to be noted, but at present they lack quantitative investigation. It has seemed worth while to give this indication that the phenomena in question are worthy of such investigation. Certain quantitative studies are being made in the Cambridge School of Biochemistry.

[5] *Jour. Physiol.*, **40**, 404; 1910.
[6] E. Walker, *Bioch. Jour.*, **19**, 1082; 1925.

Imperial Horticultural Conference.

AN Imperial Horticultural Conference, arranged by the Imperial Bureau of Fruit Production, met at the house of the Royal Society of Arts on Aug. 5-7.

The papers presented to the Conference were grouped according to the aspect of horticultural work discussed. In the group dealing with field experimentation, Mr. T. N. Hoblyn, of East Malling, stated that the failure of earlier research on fruit trees was due to (1) the inherent variability in the trees themselves, (2) variation due to outside causes. These causes of error can now be eliminated by the adaptation of statistical method to known material raised clonally. Prof. E. E. Cheesman, Imperial College of Tropical Agriculture, Trinidad, stated that the same inherent variability is markedly noticeable in tropical crops, which are largely cross fertilised and heterozygous. Here, too, in dicotyledons, clonal propagation seems to offer a solution; cacao is at present under investigation at the Imperial College at Trinidad. In the subsequent discussion, emphasis was laid on the desirability of close contact between the statistician and the horticultural worker, and on the importance of the close observation of individual trees in horticultural experiments.

Dealing with the application of the pure sciences to horticultural problems, Prof. B. T. P. Barker, Long Ashton Research Station, Bristol, remarked that chemistry can help the cider industry, particularly by determining the constituents of the apple; apples other than pure cider varieties can be used to supplement these. Investigations are in progress on the substitution of centrifuging for filtering. Prof. V. H. Blackman, Imperial College of Science and Technology, London, said that the physiological study of the effect of external conditions on horticultural crops is complicated by the interrelationship of various factors. The solution of the stock-scion problem may possibly lie in some balance of processes, for example, enzymic action, or of ratio of assimilation to respiration.

The discussion of methods of fruit storage occupied the whole of the final session. Dr. Franklin Kidd, Low Temperature Research Station, Cambridge, divides the problems into two groups: (1) those concerned with reduction of wastage and improvement of quality, using present methods; (2) those connected with the evolution of new methods. Local testing of storage qualities is desirable, as is also investigations into trade practice in handling between producer and consumer. The effects of numerous volatile substances in the atmospheres of stores need further investigation. Dr. A. Horne, Imperial College of Science and Technology, London, dealt with the infection and invasion of the apple fruit by fungi and their effect on storage quality. The presence of high fungal numbers and many pathogenic forms in an orchard are in certain cases associated with considerable wastage under ordinary storage conditions, and low numbers and few pathogenic forms with little wastage. Resistance to invasion differs greatly. Miss H. K. Archbold, also of the Imperial College of Science and Technology, showed that prolonged storage life of the apple is generally associated with a slow rate of loss of oxidisable material in respiration. Time of picking greatly influences the chemical composition and hence the storage qualities of the apple. Mr. R. G. Tomkins, Low Temperature Research Station, Cambridge, discussed the biological effect of atmospheric humidity on fruit in storage, noting its possible success in checking certain rots, its value in prolonging storage life, and the practical difficulties met. Mr. Meirion Thomas, Armstrong College, Newcastle, described the condition known as 'aldehyde poisoning'; this condition can be distinguished from brown heart by chemical analysis. The problem is proving to be of considerable economic importance.

The papers presented to the Conference will be published in full by the Imperial Bureau of Fruit Production.

The Egyptian Lily.

IN *Ancient Egypt* for September 1929 (2nd ed.), recently issued, Sir Flinders Petrie publishes the result of a comparison of some two thousand dated and placed examples of the use of the lily in decorative art. The study was undertaken with the view of demonstrating that decoration being arbitrary, unlike objects of utility which may be invented and reinvented any number of times, in its resemblances it is of great value as an indicator of the movements of trade, of culture, of conquest, and of race. The comparative study of decoration thus gives an organised method of research into ages which are without a record.

The lily motive seems to have originated in Crete. It is used in Middle Minoan III. about 2300 B.C. on the great jars of Knossos and on fresco. It was here a natural group; but by about 1600 B.C. it was modified. It appears in late Helladic of about the same time, and with a less natural form about 1400 B.C. There is a form in Rhodes which suggests that the plant was not well known there. The Cretan form passed into being merely a flower; but in Egypt it became fixed in its botanical aspect of the parts, and this permanent type went through immense changes. The detail is much more precise than on the Egyptian paintings.

In various examples different types of simplification are shown. In Hauran the different parts are maintained, but they are wildly changed in an example from Cyprus. In Persia the tips of the spathe become a bunch of dates. An Italian form at Vulci brought in sprays, and such a form passed to India, where calyx and spathe survived. A curious bowl form, proved by examination of transition forms to be the Assyrian form borrowed from the Hittite, was borrowed by Cyprus, where again the old parts were put together differently on the top of an Ionic column of Assyrian origin. A bowl pattern was brought from Cyprus or North Syria into Italy, and two patterns which can scarcely be separated from this stage turn up at Athens and Mathura, India. An inverted form appears to be a Phœnician importation into southern Etruria.

When the form was used either way up, there was more licence in the employment of leafage. Of this type a derivation appears in northern pre-Roman France, which thus must be the result of trade. The Italian form passed back to Crete. In classical times various forms are found about Rome, and by trade passed to India, appearing in the caves of Ajunta. Later still it survived at Ravenna and was worn out finally in the eighth century at Rome and at Cividale. Thus the lily as a decorative motive originated in Crete before 2000 B.C.; coming thence to Egypt it passed by 1400 B.C. to the Hittites and on to Assyria as a tree pattern. Thence transformed by ignorance it reached Cyprus and so came by Phœnician trade to the Tiber, and spread northwards from Rome, naturalised in Italy as a foliage form and finally a group of relief.

Historic Natural Events.

Sept. 8, 1900. **Galveston Hurricane.**—The hurricane of Sept. 1–12, 1900, is described as the most severe storm which ever occurred in the United States. After travelling westward south of Haiti, it curved to the north across Cuba and nearly to Florida. There it turned again to the west-north-west, and growing in intensity, struck the coast of the United States near Galveston on Sept. 8, after which it passed inland and rapidly broke up. Galveston is built on a low sandy island about thirty miles in length and two to three miles in width, and the city was completely wrecked. The anemometer recorded a velocity of 100 miles an hour when it was blown away at 2 P.M., but the velocity increased steadily until 8 P.M., at which time the corrected barometer reading was 963 mb. (28·44 in.). The storm raised the level of the sea by 15-20 feet, and the whole island was flooded. Nearly half the houses were completely destroyed by wind and sea, more than 6000 people were killed, and property to the extent of 30 million dollars was lost. Enormous losses of life and property were also reported from the coast of the mainland, but owing to the Weather Bureau warnings, only two ships were lost.

Sept. 9, 1897. **Typhoon in Sea of Japan.**—A violent typhoon travelled along the east coast of Japan, causing enormous damage. At Tokyo the wind reached a velocity of 128 miles per hour in squalls from the south. Many ships were lost; on land many houses were blown down, but the greatest damage was done by the typhoon wave, which flooded large areas and more than 5000 houses.

Sept. 10–13, 1898. **West Indian Hurricane.**—A violent hurricane passed just south of Barbados on the evening of Sept. 10, crossed St. Vincent on the morning of Sept. 11, and continuing northwards, passed east of Sombrero on Sept. 13. On Barbados 11,400 houses were swept away, about 115 lives lost, and 50,000 people rendered homeless. On St. Vincent, which experienced the full force of the storm, every exposed building or tree was blown down and 200 lives were lost. The rain was very heavy, amounting to 4·95 in. between 9 A.M. and noon on Sept. 11; probably as much fell between noon and 3 P.M., but the raingauge was destroyed. The rain filled the mountain torrents and whole villages were swept away. All shipping was destroyed. At St. Lucia an avalanche filled a valley for 3 miles, burying houses and estates. A curiosity of the storm was that at Kingstown, St. Vincent, the rain which fell was hot and stinking, and rotted clothes exposed to it; it may have come from the crater lake of Soufrière.

Sept. 10, 1899. Alaskan Earthquake.—This was one of the world's great earthquakes, for it disturbed an area of perhaps $1\frac{1}{2}$ million square miles. At the time little was known about the earthquake, for the central district was almost uninhabited. Six years later, however, the evidence of remarkable changes of elevation was still visible in raised beaches and in the bands of dead barnacles adhering to the cliffs. These showed that the coast was uplifted from a few feet to 47 ft. 4 in. Variations in the amount of elevation revealed the existence of a number of faults that divided the crust up into blocks, the tilting of which gave rise to the earthquake.

Sept. 10, 1902. Hailstorm near Maidstone.—Great damage was caused to the hop-crop in the districts around Maidstone by a violent hailstorm, accompanied by thunder. The hail in many places stripped the plants of all foliage, and the heavy rain even washed away the poles.

Sept. 10, 1903. Gale over British Isles.—During the evening and night of Sept. 10 a deep barometric depression passed rapidly across Ireland and northern England. In its front the barometer fell at the rate of nearly 5 mb. (1·4 in.) an hour, and pressure in the centre was so low as 975 mb. (28·8 in.). On the south coast of England the gale had a remarkable effect on the autumn vegetation, which was scorched brown, curled, and shrivelled up, even at places in the lee of the downs, several miles inland. This effect can scarcely have been caused by salt spray, as the storm was accompanied by very heavy rainfall.

Sept. 11, 1806. Hurricane in Porto Rico.—One of the severest hurricanes on record in the southern part of the island of Porto Rico occurred on this date. Many churches and a large portion of the houses were damaged, fruit trees were destroyed, and rivers overflowed their banks, destroying much property. At San Juan shipping suffered much loss.

Sept. 12, 1717. Triolet Glacier Outbreak.—A great moraine at the end of the glacier of Triolet, at the bottom of Val Ferret, broke up in the night, and an immense amount of débris, mixed with water and enormous blocks of ice, covered all the ground surrounding two châlets. Since then the fertile plain on which these châlets were situated has been covered by ice.

Sept. 13, 1922. Highest Recorded Temperature.—At Azizia in the semi-desert plain of Jefara, in northern Africa, between the coast of Tripolitania and the interior plateau, a maximum temperature of 136·4° F. was recorded on Sept. 13, 1922. This is the highest shade temperature ever recorded by a tested thermometer exposed under standard conditions, and is 2·3° F. higher than the previous record at Death Valley, California on July 13, 1910. The site of the station is in a shallow basin which becomes highly heated by the sun's rays.

Societies and Academies.

PARIS.

Academy of Sciences, July 16.—The president announced the death of A. T. Schlœsing, member of the Section of Rural Economy.—**Ch. Maurain, Mlle. G. Homery, and G. Gibault**: The vertical atmospheric current. At the Val-Joyeux Observatory the electric field is measured continuously and the conductivities corresponding to the positive and negative ions measured three times daily. Tables are given showing the values of the vertical currents deduced from these data.—**J. Courrègelongue and H. Maugein**: Some experiments on auto-oscillation and autorotation of immersed plates.—**Edgar Pierre Tawil**: Stationary ultra-sonorous waves made visible in gases by the method of striæ. A description of an apparatus capable of rendering visible the stationary waves produced in air by a piezo-electric crystal. Photographs are given.—**Herculano de Carvalho**: The presence of uranium in mineral waters. The uranium-radium ratio. Uranium determinations have been made in waters from five springs, the amount found being of the order of 10^{-6} gm. per litre. There was no constant ratio between radium and uranium.—**F. Bourion and Mlle O. Hun**: The determination by the boiling method of the affinity relative to the formation of the complex ammonium iodide-cadmium iodide.—**Auméras and Tamisier**: The spectrophotometric study of the cupripyridine ion in aqueous solution.—**Mme. Ramart-Lucas and J. Hoch**: The configuration of molecules in space. The absorption in the ultra-violet of the acids $C_6H_5(CH_2)_n.CO.OH$, $C_6H_5(CH_2)_n.(CO.OH)_2$ and the hydrocarbons $C_6H_5(CH_2)_nC_6H_5$.—**Sébastien Sabetay and Jean Bleger**: The chromic oxidation of the cyclanepolyols. By the oxidation of quinite in acetic anhydride solution by chromic anhydride, cyclohexandione is obtained in good yield (56 per cent theoretical yield): its physical properties and chemical reactions are given.—**Charles Dufraisse and Marius Badoche**: Researches on the dissociable organic oxides: the transformation of oxyrubrene into a non-dissociable isomer, iso-oxyrubrene. A probable formula is assigned to this oxide, but it is still difficult to suggest a formula for oxyrubrene which explains its property of dissociation with liberation of oxygen.—**Marcel Solignac**: The mineralogical characters of the oolitic iron mineral of Djebel el Ank, southern Tunis.—**Jean Lugeon**: Measurements of the ionisation, of the electric field, and of atmospherics on Mt. Blanc.

CRACOW.

Polish Academy of Science and Letters, June 2.—**C. Zakrzewski and D. Doborzynski**: Some remarks on the dielectric polarisation of the elements. The dielectric polarisation of elements not belonging to the seventh group of the periodic system is independent of the temperature, and the molecules of these elements do not possess electric dipoles. The polarisation of elements belonging to the seventh periodic group depends on the temperature, and this polarisation can be expressed by the well-known Debye formula.—**Wlad. Gorczyński**: The maximum values of the intensity of the solar radiation observed on oceans and in other regions of the earth. Whilst the ocean values do not exceed 1·4 cal. at normal incidence, 1·4–1·5 cal. is obtained on the plains and 1·7 cal. in an oasis of the Sahara. Still higher maxima are observed at high altitudes.—**H. Lachs and J. Biczyk**: The determination of the electrokinetic potential with the aid of the method of the e.m.f. of filtration.—**E. Chrobaczek**: The phenomena of correlation in wheat and the theory of associations in chromosomes. —**A. Oszacki**: The oxygen in the venous blood of human sarcoma.

SYDNEY.

Linnean Society of New South Wales, June 25.—**J. R. Malloch**: Notes on Australian Diptera (24). This paper completes the notes on Tachinidæ. Species belonging to the tribes Actiini, Linnæmyiini, Cylindromyiini, and Tachinini are dealt with. Twelve genera, one subgenus, and forty-six species are described as new, and a new name is suggested for *Phorocerosoma*, preoccupied.—**G. H. Hardy**: Fifth contribution towards a new classification of Australian Asilidæ. This paper revises the tribes Saropogonini and Stichopogonini, contrasting the Australian forms with many of the world's genera. One new genus and two new species are proposed; a table of chætotaxy, and a key to the genera are included.—**H. N. Dixon** and **W. Greenwood**: The mosses of Fiji. The mosses known from Fiji now total 205 species, about half of these having been added to the list since 1917 by the collections made by one of the authors (W. G.). This paper contains record of all the known species in Fiji, with notes of the localities from which the species have been collected. A key is given to the genera found; twenty-seven species and five varieties are described as new.

ROME.

Royal National Academy of the Lincei, April 6.—**V. Volterra**: Hereditary mechanics. The energetics of hereditary mechanics, limited to the case of linear hereditary actions, was recently considered. The case of non-linear actions for a system with only one degree of freedom is now treated.—**T. Levi-Civita**: Further consideration of the motion of a body of variable mass.—**G. Hagen**: Photographed oscillations of the free pendulum.—**F. Vercelli**: General method for the analysis of the periodicities in statistical and experimental diagrams.—**G. Silva**: The formula of normal gravity.—**G. Tizzoni** and **G. De Angelis**: Immunity against the adeno-carcinoma of the mouse conferred by the pulp of the tumour itself with addition of formol. The phenolated vaccine previously tried causes mainly an anti-neoplastic immunity, whereas the formolated vaccine results principally in anti-toxic immunity.—**A. M. Bedarida**: The infinity of prime numbers in quadratic forms.—**G. Barba**: The functional equation $f(x)f^1(x)=f[f(x)]$ connected with a geometrical problem. The form of the intrinsic equation of a curve in order that this may be similar to its evolute, is considered.—**P. Cattaneo**: A class of cyclic varieties.—**I. J. Schwatt**: The development of $\sec^p x$ in Maclaurin's series.—**A. Belluigi**: The topographical corrections in Eötvös remainders.—**E. Segrè**: Statistical calculation of the spectrum of an ionised atom. The statistical method is applicable to the construction of the spectrum of an ionised atom from the atomic number and the degree of ionisation. Even with highly ionised atoms the method furnishes satisfactory results.—**G. Bargellini** and **A. Grippa**: 2 : 5-Dibromoanisidine. This compound and several of its derivatives are described.—**G. Bargellini** and **F. Madesani**: 3 : 5- and 2 : 6-Dibromoanisidines. Bromination of acetyl-*p*-anisidine yields the acetyl derivative, not of 3 : 5-, but of 2 : 5-dibromoanisidine. —**G. Natta**: Crystalline structures of hydrogen sulphide and hydrogen selenide (1). X-ray investigation indicates that hydrogen sulphide and hydrogen selenide crystallise in the cubic system. For the former, the side of the unit cell is $5{\cdot}778 \pm 0{\cdot}003$ A. and its volume $192{\cdot}9 \times 10^{-24}$ c.c. On the assumption that the unit cell contains four molecules and that the weight of the hydrogen atom is $1{\cdot}65 \times 10^{-24}$ gm., the density of solid hydrogen sulphide at $-170°$ is calculated to be 1·166.—**G. A. Barbieri**: Reduction of silver ferricyanide by means of ferrous sulphate. Under suitable conditions, ferrous ions may reduce ferricyanogen ions, even in acid solution. This reaction is applicable to the determination of ferricyanides.—**S. Visco**: Action of the latex of *Ficus carica* on proteins. The action of this latex on the proteins constituting the albumen of hens' eggs does not proceed beyond the formation of products of the character of secondary proteoses.—**S. Sorrentino**: The older formations of Monte S. Calogero and of Nadure near Sciacca.—**L. Maddalena**: Study of a phenomenon exhibited by the Aurisina stone used for covering walls. When this stone is used for outside constructional work, yellowish rusty spots, often zoned, gradually develop on it, and, after increasing in diameter to 15-20 cm., slowly fade and finally almost disappear. This phenomenon is due to the formation of colloidal iron hydroxide (hydrosol) by the oxidation of the pyrites present to ferrous sulphate and interaction of this with the lime of the mortar in presence of slightly alkaline water. Moisture easily transports the colloid to the outer surface of the porous stone, where it is first fixed as hydrogel by evaporation of the water and later washed away by the mechanical action of rain.—**C. Artom**: Origin and evolution of parthogenesis in *Artemia salina diploide* of Cette.—**P. Pasquini** and **G. Meldolesi**: Investigations on radio-sensitivity in the development of the eggs of amphibia (2). Specific alterations and secondary malformations from differential radio-susceptibility in *Rana esculenta*.—**N. A. Barbieri**: Improvement in the metabolism of plants by physiological culture without alteration of the soil. Experiments with *Cattleya*, maize, beans, potatoes, sugar-beet, etc., confirm the advantages of the author's method of homogeneous mineral culture, which consists of localised application of a mixture of the soluble and insoluble salts existing preformed in the plants in the amount required by the whole of the crop.—**V. Rivera**: Radiation and growth in plants—development under a leaden screen.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 16, No. 5, May 15).—**A. E. Navez**: On the distribution of tabular roots in *Ceiba* (Bombacaceæ). In Cuba, the so-called buttress or tabular roots of these trees grow principally on the sides struck by the dominant winds, the largest generally in the N.E.-E.N.E. direction. The roots are 'resistance cables' rather than 'buttresses'.—**Ernest Glen Wever** and **Charles W. Bray**: Action currents in the auditory nerve in response to acoustical stimulation. A decerebrated cat was used and electrodes placed on the exposed auditory nerve. Sound stimuli applied to the animal's ear set up action currents which, when amplified, produced sounds in a telephone apparently identical with the original stimulus. Speech was transmitted with great fidelity; response was obtained with frequencies between 125 and 4100 ~ per second. Frequency of response is correlated with frequency of stimulation. —**Robert K. Nabours**: Mutations and allelomorphism in the grouse locusts (Tettigidæ, Orthoptera). —**F. H. Murray**: The electromagnetic field exterior to a system of perfectly reflecting surfaces. A mathematical discussion.—**Louis S. Kassel**: The rates of second-order gas reactions. A theoretical discussion based on the assumption that the chance of reaction at a collision increases with energy of collision.—**Ernest W. Brown**: On the prediction of trans-Neptunian planets from the perturbations of Uranus. —**Edwin H. Hall**: The 'reaction-isochore' equation for ionisation within metals.—Sinclair Smith: The effect of low temperatures on the sensitivity of radiometers. Radiometers in hydrogen, helium, and air in a specially designed chamber at – 180° C. were exposed to light from a controlled source. Maximum sensitivity increases at low temperature and shifts towards lower pressures.

Official Publications Received.

BRITISH.

Mines Department. Eighth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1929. Pp. 62. (London: H.M. Stationery Office.) 1s. net.

Astrographic Catalogue 1900·0. Sydney Section, Dec. -51° to -65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 11: R.A. 12h to 18h, Dec. -53° to -55°, Plate Centres Dec. -54°. Pp. 86. Vol. 12: R.A. 18h to 24h, Dec. -53° to -55°, Plate Centres Dec. -54°. Pp. 43. (Sydney, N.S.W.: Alfred James Kent.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 38: A Study of the Polysaccharides. Part 2: Note on the Purification of the Natural Products. By J. Reilly and Declan T. McSweeney. Pp. 451-453. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

The North of Scotland College of Agriculture. Calendar, Session 1930–1931. Pp. viii+120. (Aberdeen.)

Proceedings of the Royal Society. Series A, Vol. 128, No. A808. Pp. 361-666. (London: Harrison and Sons, Ltd.)

The Journal of the Ipswich and District Natural History Society. Edited by Henry Ogle. Vol. 1, Part 2. Pp. ii+71-140. (Ipswich.)

Imperial Agricultural Bureau. Bulletin No. 1: Miscellaneous Information relating to Breeding of Herbage Plants. Pp. 22. Plant Genetics: Herbage Plants. Catalogue of Journals and Periodicals in the various Libraries in Aberystwyth to which the Bureau has Access. Supplement to Bulletin No. 1, 1930. Pp. 10. (Aberystwyth.)

The Rowett Research Institute. Collected Papers, Vol. 2. Edited by Dr. John Boyd Orr. Pp. xv+588. (Aberdeen.) 21s.

Forestry Commission. Tenth Annual Report of the Forestry Commissioners, Year ending September 30th, 1929. Pp. 69. (London: H.M. Stationery Office.) 1s. 3d. net.

FOREIGN.

Proceedings of the Imperial Academy. Vol. 6, No. 6. Pp. xix-xxi+217-242. (Tokyo.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 14, No. 1. Pp. 96+28 plates. Fourth Series (Biology), Vol. 5, No. 2. Pp. 215-422+plates 9-14. (Tokyo and Sendai: Maruzen Co., Ltd.)

Svenska Hydrografisk-Biologiska Kommissionens Fyrskeppsundersökning. År 1929. Pp. 45. (Göteborg: Elanders Boktryckeri A.-B.)

Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 7, No. 1. Pp. 99. (Tokyo: National Research Council of Japan.)

Annales de l'Observatoire de Paris: Section d'Astrophysique à Meudon. Tome 8, Fascicule 2: Recherches sur la structure de la chromosphère solaire. Par L. D'Azambuja. Pp. iii+120+10 planches. (Paris: Gauthier-Villars et Cie.)

Proceedings of the American Philosophical Society. Vol. 69, No. 5. Pp. 257-294. (Philadelphia.)

Division of Fish and Game of California. Fish Bulletin No. 22: A Bibliography of the Tunas. By Genevieve Corwin. (Contribution No. 87 from the California State Fisheries Laboratory.) Pp. 103. (Terminal, Calif.: California State Fisheries Laboratory.)

Bulletin of the Vanderbilt Marine Museum. Vol. 1, Art. 2: Scientific Results of the Yacht *Ara* Expedition during the Years 1926 to 1930, while in Command of William K. Vanderbilt. Fishes (collected in 1929). By N. A. Borodin. Pp. 39-64+2 plates. (Cambridge, Mass.: The Cosmos Press, Inc.)

Ministry of Public Works, Egypt: Physical Department. Physical Department Paper No. 27: Upper Winds at Cairo and Khartoum. By L. J. Sutton. Pp. 52+6 plates. (Cairo: Government Press.) 10 P.T.

CATALOGUES.

Photography Simplified: Printing and Toning. Pp. 12. (London: Burroughs Wellcome and Co.)

A Catalogue of Important Scientific Books containing Standard and Rare Works on Ornithology, Zoology, Ecology, Entomology, Botany, Forestry, Mathematical and Physical Sciences, Natural History in General. Pp. 30. (London: W. and G. Foyle, Ltd.)

The Nickel Bulletin. Vol. 3, No. 8, August. Pp. 241-280. (London: The Mond Nickel Co., Ltd.)

Diary of Societies.

CONGRESSES.

SEPTEMBER 3 TO 10.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Bristol). (*For particulars see* NATURE *of Aug. 30.*)

Change of Programme.—(B) *Sept.* 9, at 11 A.M.—Prof. C. S. Gibson and Prof. J. L. Simonsen: Some Recent Investigations of Organic Compounds of Gold; instead of Prof. Semenoff: The Initiation of Combustion.

SEPTEMBER 4 TO 14.

INTERNATIONAL ZOOLOGICAL CONGRESS (at Padua).

SEPTEMBER 7 TO 13.

INTERNATIONAL CONGRESS OF AMERICANISTS (at Hamburg).—Papers on The Aboriginal Peoples of America and their Ethnic Relations, The Prehistory of America, Manners and Customs of the Various Groups of Indians and their Distribution in the Old and New World, The Aboriginal Languages, The Discovery and Colonisation of America, The Geography and Geology of America, with Special Reference to Human Activities, and a Discussion on The Civilisation of the Indians at the time of their first contact with Europeans and to-day.

SEPTEMBER 8 TO 12.

INTERNATIONAL CONFERENCE OF THE APIS CLUB.

Monday, Sept. 8 (at Apothecaries' Hall, Water Lane, E.C.), at 3.30.—Miss Annie D. Betts: The National Importance of Apiculture (Presidential Address).

Wednesday, Sept. 10 (at Crystal Palace).—Dr. G. Morison: Notes on Acarine Disease.

Thursday, Sept. 11 (at Crystal Palace), at 11 A.M.—Dr. H. W. de Boer: Behaviour of Diastatic Ferments in Honey when Heated.

At 12 noon.—C. H. Hooper: Fruit Pollination and the Importance of Insect Visitors in Fruit Production.

At 2.30.—D. Morland: Frosting.

At 5.30.—Dr. F. Kretschy: Our Bee as Doctor.

At 6.30.—L. M. Bertholf: The Distribution of Stimulative Efficiency in the Ultra-Violet for the Honey Bee.

Friday, Sept. 12 (at Crystal Palace), at 11 A.M.—M. le Chanoine A. Delaigues: Transformism.

At 12 noon.—Dr. J. Stitz: Ultra-Violet Absorption of Honey.

SEPTEMBER 9 TO 12.

INSTITUTE OF METALS (at Southampton).

Tuesday, Sept. 9 (in Chantry Hall), at 8 P.M.—Prof. D. Hanson: The Use of Non-Ferrous Metals in the Aeronautical Industry (Autumn Lecture).

Wednesday, Sept. 10 (in Chantry Hall), at 10 A.M.—E. A. Smith: Rolled Gold: Its Origin and Development.

Dr. W. Rosenhain, J. D. Grogan, and T. H. Schofield: Gas Removal and Grain Refinement of Aluminium Alloys.

J. D. Grogan: Pressure Die-Cast Aluminium Alloy Test-Pieces.

N. W. Ageew and Olga I. Vher: The Diffusion of Aluminium into Iron.

Dr. K. L. Meissner: The Artificial Ageing of Duralumin and Super-Duralumin.

Dr. W. L. Fink and Dr. K. R. Von Horn: Lattice Distortion as a Factor in the Hardening of Metals.

Dr. Marie L. Gayler: A Study of the Relation between Macro- and Microstructure in Some Non-Ferrous Alloys.

Thursday, Sept. 11 (in Chantry Hall), at 10 A.M.—Dr. J. C. Hudson: The Effect of Two Years' Atmospheric Exposure on the Breaking Load of Hard-Drawn Non-Ferrous Wires.

Dr. W. H. J. Vernon and L. Whitby: The Open-Air Corrosion of Copper. Part II. The Mineralogical Relationships of Corrosion Products.

Dr. E. Voce: Silicon-Copper Alloys and Silicon-Manganese-Copper Alloys.

E. Vaders: A New Silicon-Zinc-Copper Alloy.

H. C. Dews: The Effects of Phosphorus on the Strength of Admiralty Gun-Metal.

Dr. D. Stockdale: A Note on the Constitution of the Cadmium-Zinc Alloys.

Prof. G. Tammann: On the Determination of Crystallite Orientation.

D. A. N. Sandifer: Pendulum Hardness Tests of Commercially Pure Metals.

F. Hargreaves: Heat-Treatment, Ball-Hardness, and Allotropy of Lead.

SEPTEMBER 11 TO 14.

SWISS SOCIETY OF NATURAL SCIENCES (at St. Gallen).—In sixteen sections covering Pure and Applied Science and Medicine. Addresses by Prof. E. Abderhalden, on The Significance and Mechanism of Ferments in Nature; Prof. P. Niggli, on Ten Years' Work of a Mineralogical and Petrographic Institute; Prof. R. Chodat, on The Symbiosis of Lichens and the Problem of Specificity; and Prof. C. Wegelin, on Endemic Cretinism.

SEPTEMBER 13 TO 20.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Liverpool).

SEPTEMBER 15 TO 20.

IRON AND STEEL INSTITUTE (in Czechoslovakia).

Monday, Sept. 15, at 10 A.M.—A. Kříž: The Heterogeneity of an Ingot made by the Harmet Process.

J. Šárek: What Reasons Compelled the Prague Ironworks to Introduce Thin-Walled Blast-Furnaces.

W. H. Hatfield: Permanence of Dimensions under Stress at Elevated Temperatures.

Tuesday, Sept. 16, at 10 A.M.—O. Quadrat: A Contribution on the Problem of the Analysis of Basic Slags and the Representation of their Composition in a Triangular Diagram.

H. C. Wood: Open-Hearth Furnace Steelworks. A Comparison of British and Continental Installations and Practice.

D. F. Campbell: High-Frequency Steel Furnaces.

L. W. Schuster: The Effect of Contamination by Nitrogen on the Structure of Electric Welds.