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Chemical Societies and Co-operation

THE industrial complexion of the present-day world, with its political and financial complications, has of necessity led numerous institutions concerned with the production and distribution of commodities, and with means to assess and exchange their value, to abandon convenient and traditional procedure and to discover alternatives which have the merit, under the new conditions, of combining self-preservation with the supply of the public needs. The science of chemistry has been harnessed to the industrial machine with a rapidity which appeared unlikely twenty years ago, and its record of service is already such as to presage the extension, as quickly as the difficulties of the moment permit, of this collaboration.

Responsibility for promoting such co-operation is shared by the Government and other public bodies, by industrialists, and by the chemical profession itself; but whilst the acquisition of chemical knowledge is a task shared directly or indirectly by all of these, its distribution is a burden which is borne almost entirely by the producers themselves. Hence many institutions devoted to the extension of scientific knowledge are faced with the same problems as the interests to the assistance of which they have been summoned. They have now to consider afresh how they can best realise their increasing responsibilities towards the national needs, while at the same time finding means to guard against serious deterioration of their distributing organisation.

Chemical societies, in common with other scientific bodies, are not greatly—if at all—concerned with questions of professional rewards, for the care of which provision is made by appropriate professional organisations. They acknowledge that it is one of their duties to promote scientific intercourse among their members, and to make such provision as may be deemed necessary to facilitate research and its discussion; but the principal duty which is laid upon them by common consent as well as by the force of circumstances is to publish to the world the records of original investigation, to do so as far as is possible without any restriction other than the scientific value of the material, and to prepare and distribute summaries of current researches in a world-wide or limited field.

This twofold publication is the very foundation of all new knowledge, and the disastrous effect of any appreciable curtailment—apart from such devices for abbreviation as may be easily intelligible to workers in the science—is only too fully realised. Consequently, much serious consideration has of

late been given to the possibility of reorganisation, co-operation, federation, and unification of the various societies devoted primarily or exclusively to promoting advance in chemical knowledge. It is, for example, scarcely fortuitous that Prof. G. T. Morgan dealt at some length with the subject in his presidential address to the Society of Chemical Industry in July, and that Prof. G. G. Henderson's presidential address to the Chemical Society in March also referred to the matter; neither were Prof. J. F. Thorpe's observations in his presidential addresses to the Chemical Society in 1930 and 1931 intended for the consideration only of fellows of that Society. Indeed, although these two chemical societies have properly taken the lead in the examination of the position and in the suggestion of methods whereby present difficulties may be surmounted and future progress assured, the problem is one which vitally concerns every chemical association and every research laboratory in the British Commonwealth.

Naturally enough, delicate and complex considerations arise with every suggestion of reunion or federation—two methods whereby considerable economy in administrative costs without contraction in scientific services might be anticipated—but encouragement is to be found in the manner in which these difficulties are being examined and discussed. Moreover, confidence arises from the fact that, for the past eight years, a substantial measure of joint operation has been successfully achieved in connexion with the publication of abstracts of chemical literature. It is well known that, by the establishment in 1924 of the Bureau of Chemical Abstracts, a body composed of representatives of the Chemical Society and the Society of Chemical Industry and charged with the production of a comprehensive and world-wide survey of current researches in both pure and applied chemistry, substantial economies have been rendered possible, while at the same time the ever expanding literature of the science is summarised and indexed with commendable accuracy, promptitude, and completeness. There can be few among those conversant with the work of this undertaking, with the needs of research workers both in academic and in industrial laboratories, and with the moderate financial resources at the command of the two societies, who would not declare this experiment in co-operative enterprise to be an unqualified success; indeed, we are unaware of any suggestion having been made that the older procedure, with its inherent lack of co-ordination and inevitable duplication, should be resumed. Few, too, would contest the desirability, in general, of a wider measure of co-operation in which other societies would participate, in order that efficiency might go hand in hand with elasticity and stability, and that the financial clouds which obscure clear vision of the future and cause anxiety for the continued supremacy of British Chemical Abstracts might be dissipated once and for all.

In his address Prof. Morgan quoted some pertinent facts and equally instructive figures; even if we admit that the exact significance of both depends on the point of view, we are still constrained to point out the inequity of so severe a task—albeit but part of the whole duty of publication—being left on the shoulders of two out of perhaps sixteen societies which are devoted to the furtherance of chemistry in one or other of its branches. Earlier this year Prof. Henderson referred to this circumstance with commendable frankness. "On these two societies alone", he said, "falls the financial burden of this great work, work which is for the benefit of every chemist in the country. It is singular and anomalous that hundreds, perhaps even thousands, of professional chemists exist here, who make no contribution to this burden, who do nothing to help the cause of chemistry in the way that is most urgent, most necessary, and most expensive." Likewise Prof. Thorpe in 1931 said: "The burden of publication now falls almost exclusively on the Chemical Society and the Society of Chemical Industry, and although it is probably correct to assume that the Journals of these Societies are of interest chiefly to their members, such an assumption cannot be made in the case of the Abstracts, which ought to be of interest to all chemists, and ought to be supported by all chemists." Indeed, we would go even further and submit that the fundamental importance of chemistry to our national prosperity lays upon the State itself the duty of rendering timely assistance in this matter.

We come, therefore, to the following conclusions: First, that the present financial circumstances of the chemical societies of Great Britain demand either curtailment of services to chemists of all descriptions, or some countervailing form of retrenchment. Second, that the reduction in administrative expenses which in the course of time would follow unification or some form of very close association would assist in removing these financial difficulties, and would at the same time promote solidarity and efficiency. Third, that a substantial experiment in joint publication has proved successful over a considerable period. Fourth, that the cost of, and responsibility for, certain

essential activities ought to be shared more widely. Taken together, they present an almost unanswerable case for amalgamation or federation, although of course they do not indicate exactly how it is to be achieved. As Prof. Morgan has pointed out, advocates of reunion have to face the fact that certain kindred societies have a mixed membership, consisting only partly of chemists; yet this has not deterred the Faraday Society and the Chemical Society from entering into conversations with the view of undertaking joint publication representative of physical chemistry in Great Britain. It has also been suggested that the news section of *Chemistry and Industry* should be published by a combination of the main chemical associations, and should be "an outward and visible sign of the reunion to which many of us aspire". "Is it not high time", asked Prof. Morgan, "that we evolved a considerable chemical organisation with a comprehensive chemical journal worthy of that community of nations known as the British Empire?"

Many of us, while not pretending that geographical boundaries can circumscribe the sciences, feel strongly that the national consciousness of British scientific achievement might with advantage be stimulated in this way and by other like means. "Chemistry House", which would have commanded public interest, was conceived as a means whereby the various societies representing chemistry and allied subjects might be brought into close physical association, so that certain activities, such as the library and a bureau of information, might be conducted jointly. Unfortunately, the project was born into a world of financial, political, and economic unrest, which soon became a panic, and the scheme must now submit to rebirth in less troublous times. Here again is a plan which carries with it the certainty of eventual economic advantage combined with that increase in effective service which cannot fail to accompany centralisation and the multiplication of opportunities for co-operation, if indeed it does not lead to the actual regrouping of chemical societies in larger units.

It ought not to be impossible by other methods, however, to secure a substantial part of the economies adumbrated by the "Chemistry House" scheme, and to do so relatively cheaply and without pressing the thorny questions of amalgamation or autonomy to an immediate decision. With this aim Sir William Pope, in a communication to *Chemistry and Industry*, recently proposed that Mr. E. R. Bolton, Dr. L. H. Lampitt, Prof. G. T. Morgan, Prof. J. C. Philip, Mr. J. Davidson Pratt, Dr. F. L. Pyman, and Mr. W. Rintoul, as representing the principal societies concerned, should be asked to constitute a committee which would consider how the resources of the various bodies concerned with the professional and scientific welfare of chemists can be most economically and efficiently utilised. If, for example, administration could be concentrated under one head in one building, the Chemical Society's library and rooms at Burlington House continuing to be the chief centre of scientific and technical activity, substantial mutual advantage would doubtless result.

But why, it may be asked, should these considerations of unity or separation, of co-ordination or non-co-operation, of economy or stringency, be regarded as matters of interest to citizens outside the ranks of the chemical profession? Why, we might reply, were the conversations at Ottawa of interest to others besides professional politicians and economic theorists? At least they have this in common: that the science of chemistry and the science of government, each depending for its operation and extension on a highly trained 'civil service' and on adequate and accurate information, are both deeply concerned with the resources of the British Empire and with the use that we and our fellow-subjects overseas can make of them. "The time is ripe", Prof. Morgan said, "for a systematic study of the material resources of the British Empire, and this task is mainly a chemist's job. Many of the natural products of the Dominions and Dependencies are in need of intensive chemical investigation. To carry out such researches in a thoroughly effective and comprehensive manner needs the expert organisation which could be best supplied by a central body fully representative of British chemistry. Every branch of chemical science would have an essential part to play in this great undertaking."

Benjamin Franklin

The Ingenious Dr. Franklin: Selected Scientific Letters of Benjamin Franklin. Edited by Nathan G. Goodman. Pp. xi + 244. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1931.) 15*s*. net.

CENTENARIES are fashionable nowadays, and certainly the bicentenary of the Philadelphia Library is a day to be marked with a white stone. Franklin's restless and versatile mind was ever occupied with schemes for human betterment, and one of the most beneficial of his many beneficent deeds is perpetuated in the inscription telling us that ". . . the Philadelphia Youth [then chiefly

artificers] . . . in MDCCXXXI . . . cheerfully, at the instance of Benjamin Franklin, one of their number, instituted the Philadelphia library ".

Franklin's activities and personality are buried in some ten volumes of his collected works. One-volume editions of his life and works have seen the light—the reviewer possesses one published at Bungay in Suffolk in the early years of the nineteenth century, but he is unacquainted with any modern critical selection, and the choice of the year 1931 to give to the twentieth-century reader some notion of the many-sidedness of Franklin's genius was a very happy one.

To the reviewer's mind, the execution of the idea is somewhat imperfect—to confine the volume to a selection from the scientific letters alone is to give a very lop-sided picture of the career and character of Franklin. And an amazing picture it is, even for a society so homely that we find the Governor of Pennsylvania hobnobbing in a tavern over a bottle of madeira with an obscure printer's apprentice, even for an America of such incredibly minute dimensions that Franklin's brother was accounted over-daring in initiating the *New England Courant*, the *three* already existing newspapers being regarded as more than sufficient for the needs of the continent. That picture is not brought out by a perusal of the letters alone, and our ideal Franklin memorial volume must certainly contain, to begin with, the autobiography, complete and unabridged.

The study of a personality is always fascinating, and Franklin's autobiography opens to us a masterful, sententious, frugal, and inquiring mind, a mind which, none the less, appreciates and sympathises with human weaknesses and is not afraid to chronicle its own lapses. Truth to tell, some of Franklin's endeavours to cultivate the morals, major and minor, are apt in these days to raise a smile. He would indeed be an exceptional youth who should to-day draw up a schedule of thirteen virtues wherein to test himself, concentrating each week on one particular merit, and endeavouring to keep the daily squares allotted to it free from the black marks which indicate a lapse. Yet Franklin conscientiously carried out such a programme, completing it in thirteen weeks, and repeating it four times in a year. The schedule reproduced shows the results of a week's analysis, during which he had elected to concentrate on temperance.

A carping critic may find something of smugness in such a record, which is not apparent to those who know the autobiography in detail; it is not all a tale of achievement, and some of us can sympathise, ruefully enough, with Franklin's efforts to cultivate order and method, and his resolve at times to be content with a second-best.

TEMPERANCE

"Eat not to dullness; drink not to elevation."

	Sun.	M.	T.	W.	Th.	F.	S.
Tem.							
Sil.	×	×		×		×	
Ord.	×	×			×	×	×
Res.		×				×	
Fru.		×				×	
Ind.			×				
Sinc.							
Jus.							
Mod.							
Clea.							
Tran.							
Chas.							
Hum.							

"Like the man", as he himself says, "who, in buying an axe of a smith, my neighbour, desired to have the whole of its surface as bright as the edge. The smith consented to grind it bright for him, if he would turn the wheel; he turned, while the smith pressed the broad face of the axe hard and heavily upon the stone, which made the turning of it very fatiguing. The man came every now and then from the wheel to see how the work went on; and at length would take the axe as it was, without further grinding. 'No,' said the smith, 'turn on, turn on, we shall have it bright by and by; as yet it is only speckled.' 'Yes,' said the man, 'but *I think I like a speckled axe best.*'"

There are many of us who, in higher virtues than that of order, find that we like a speckled axe best.

The reader of the autobiography will find it not without interest to turn over the pages of the confessions of Rousseau, who was writing at about the same period as Franklin. The outpourings of such an introspective Heautontimorumenos as Jean Jacques differ *toto cœlo* from the calm record of Franklin. The extraordinary incident of the kettle, the story of the stolen riband, and the adventure of Madame de Warens are part and parcel of the fascinating, if sometimes repellent, character of Rousseau; Franklin's lapses from the major virtues, faithfully chronicled as they are, are but passing incidents in a life devoted whole-heartedly to the advancement of knowledge and to the practical betterment of mankind.

His long life, stretching from 1706 until 1790, saw many changes; none more striking than the metamorphosis of the printer's apprentice of 1718 to the Minister-Plenipotentiary to France of 1778, and the President of Pennsylvania of 1785. Any adequate volume dealing with Franklin must trace

this change, and it can nowhere be better followed than in the autobiography which takes us to 1757, and in a discreet abridgment of Jared Sparks' continuation of the autobiography.

The selections in the admirably printed and produced volume before us illustrate sufficiently well the varied nature of Franklin's scientific work, and the practical character of his genius. We see him designing lightning rods and bifocal lenses; discussing the best form of stove fireplace; observing the effect of oil in stilling waves—an experiment Franklin first performed on a pond on Clapham Common—and carrying, "whenever I went into the country, a little oil in the upper hollow joint of my bamboo cane, with which I might repeat the experiment as opportunity should offer"; mounting musical glasses, suitably tuned by filing, on a common horizontal spindle which could be worked by a treadle, and thus devising the instrument called the armonica; sending up his kite of cedar-wood and silk fabric, with a key at the lower end of the string, into a thunder-cloud, and—hardy fellow—telling his correspondent that "when the rain has wet the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle"; giving lessons in the art of swimming, in the art of procuring pleasant dreams, and, generations before the advent of *Nacktkultur*, rising early and sitting in his chamber "without any clothes whatever, half an hour or an hour, according to the season, reading and writing".

Eripuit caelo fulmen, sceptrumque tyrannis. There is much in this volume concerning the wresting of the lightning from heaven (though there is a strange omission of the important letter to Peter Collinson of September 1753), much which illustrates Franklin's minor scientific activities. But we miss the familiar dialogue between Franklin and the Gout; we miss the sententious aphorisms of Poor Richard, and the story of the whistle; we miss those letters which reveal Franklin as a statesman and, in particular, the details of his examination before the House of Commons in 1766 relative to the repeal of the American Stamp Act.

It is, of course, entirely within the province of an editor to delimit the area of his selections, and the present volume is definitely a selection of scientific letters, which provides most interesting and varied fare for the reader. Nevertheless, one cannot but feel that an opportunity has been missed, and that the ideal one-volume edition on Franklin still remains to be published.

ALLAN FERGUSON.

The Value of Scientific Knowledge

(1) *Reason and Nature: an Essay on the Meaning of Scientific Method.* By Morris R. Cohen. Pp. xxiv + 470. (London: Kegan Paul and Co., Ltd., 1931.) 21*s.* net.

(2) *Science and First Principles.* By Prof. F. S. C. Northrop. Pp. xiv + 299. (Cambridge: At the University Press, 1931.) 12*s.* 6*d.* net.

(3) *The Logic of Science.* By Prof. Harold R. Smart. Pp. viii + 237. (New York and London: D. Appleton and Co., 1931.) 8*s.* 6*d.* net.

(1) MODERN thought undoubtedly suffers from the actual hostility between Nature and reason, which were once joined in the Hellenic ideal of science. The appeal for an effective and conscious union of these two fundamental elements of science is inspiringly illustrated in Prof. Cohen's work, which thus carries under its learned guise a constructive message to philosophers and men of science. Prof. Cohen believes neither in a conventional supernaturalism nor in a sentimental irrationalism, but he finds much inspiration in the older thinkers, and he is thus led to make this modest but useful, if not heroic, pronouncement: "The philosopher, whose primary interest is to attain as much truth as possible, must put aside as a snare the effort of originality. Indeed, it seems to me that the modern penchant for novelty in philosophy is symptomatic of restlessness or low intellectual vitality." It is in this spirit of a true friend of wisdom that he surveys the general meaning of the principles of procedure according to which scientific results are obtained and according to which these results are being constantly revised.

In the first part of the book, Prof. Cohen deals with the mental attitudes, such as historicism, psychologism, authority, pure experience, intuition, and creative imagination, which seem to guide the modern research worker. The two remaining parts are devoted to an analysis of natural science, including biology and psychology, and of social science, with special reference to the postulates of reason.

Taking at random one example of Prof. Cohen's inquiry—that which deals with the nature of mathematics—we find him discussing the logical character of pure mathematics, their relation with intuition, and the important question of how applied mathematics is possible. His general conclusion is that the relational structure of mathematics, which is their very object, is just as objective as the physical entities related; and that the laws of mathematics are applicable, because they are the

laws according to which all objects or realities can be combined. The assumption that numbers and mathematical or logical laws are mental is due, according to Prof. Cohen, to the "vulgar prejudice" that only particular sensible entities exist in Nature, and that relations, abstractions, or universals cannot have any such objective existence. "But this is a shabby subterfuge: for these numbers or relations are also numbers and relations of things; and any assertion with regard to these abstractions is either true or not. Now truth, whatever it is, is not a quality which inheres in a proposition simply because it is mental, but a proposition is true because of factors other than the fact that I now think this proposition" (p. 203). It follows that logic and pure mathematics apply to Nature because they describe the invariant relations which are found in it; and thus they enable us to extend our knowledge of Nature by supplying us with illuminating perspectives and by insisting on relevance which is a condition of sanity.

(2) A similar attitude, but perhaps with a more pragmatic inclination, seems to be adopted by Prof. Northrop in discussing the claims of modern theoretical science. He also thinks that the complexity, richness, and beauty of the scientific, æsthetic, and religious experience find their source in the happy combination of these three fundamental principles: the primacy of motion, the source of rationality and necessary order in the physical referent for motion, and the identification of the purely psychical with bare indeterminate experienced quality. This view leads Prof. Northrop to describe reality, as known by scientific philosophy, as æsthetic immediacy with its physical, formal, and psychical conditions made specific. As an example of his conception of the standard thinker, he gives us Leonardo da Vinci, for whom "the physical and the formal were grasped without being torn from the vivid psychical immediacy in which both are embedded".

The importance of these general ideas is illustrated by some very interesting considerations on certain specific scientific theories, such as the theory of relativity, the quantum and wave mechanics, and the fundamental principles of biology and anthropology. For example, in discussing the various aspects of the theory of relativity, Prof. Northrop suggests that the conclusions reached in connexion with the necessary consequences of the theory, if properly treated, should possess equal certainty, since they merely designate what else must be true if the theory is true. But he holds that the theories of the finite universe of Einstein and de Sitter, and the unitary field theories of Weyl, Eddington, and Einstein, rest on more questionable assumptions, and lack the experimental verifications which Einstein's earlier discoveries enjoy. Thus Prof. Northrop is led to think that the physical theory of Nature in a kinetic atomic form must be true; for after introducing and recognising more relativity than even the most imaginative speculative mind has ever conceived, Einstein's discoveries reveal that there is something absolute in Nature, remaining objective and invariant through all the relativity which exists, and that this absolute factor is matter and motion.

(3) The necessity of hanging the bulk of our scientific knowledge to something real, something absolute beyond the fact of perception, is also prominent in the analysis of the sciences proposed by Prof. Smart. His object is to answer some pertinent questions which arise necessarily in one's mind when one contemplates the lofty achievements of modern science. Is mathematical knowledge the product of pure thought functioning apart from all experience? Should we say that physics is a branch of geometry? Or does it tell us only of a certain orderliness amongst our purely subjective perceptions? Are substance and causality outworn conceptions, no longer applicable to natural phenomena? What possible solution can be proposed to the interminable struggle between mechanists, teleologists, and vitalists in biology?

These and other queries show the range of Prof. Smart's considerations. Generally speaking, he is of opinion that a *via media* suggests the best solutions to these fundamental problems with regard to biology; for example, he believes that in the biological sciences, the conception of natural kinds dominates the search for laws, somewhat as physical conceptions condition the application of mathematical principles to physical phenomena. As for mathematics, Prof. Smart suggests that the mathematician shares with other natural scientists the content supplied by the world of existential phenomena. The hypothesis of pure mathematics being a completely *a priori* science, functioning apart from all experience, is denounced as the enemy of all science and philosophy, because it lands us into all sorts of impossible dualisms and irresolvable contradictions.

Reaching by degrees the universal plane of philosophy, Prof. Smart contends that scientific knowledge constitutes itself a revelation not only of Nature, but also of mind itself, which presupposes, however, the independent existence of Nature. Consequently, a law of Nature ultimately implies both an objective order of which it is a representa-

tion, and a principle of intelligibility of which it is an expression. It follows that the task of philosophy involves the differentiation and integration of these several values in a systematic unity.

There is no doubt that the considerations put forward by these three writers will make a wide appeal to those whose experience in the field of speculation has led them to believe that present-day science seems to be struggling along against a sense of unreality. Extreme views in the interpretation of our scientific knowledge can be useful during a certain time, for they suggest new problems, novel solutions, and original methods of approach. But they can scarcely hold the field permanently; and the time now seems to have come when some kind of reasonable unification is desirable. This unification is the more important as the general crisis in which our society appears to be involved can scarcely find a satisfactory solution if leaders of thought are not certain amongst themselves as to the real value of their knowledge.

THOMAS GREENWOOD.

Furs and Feathers

Die Rohstoffe des Tierreichs. Herausgegeben von Ferdinand Pax und Walther Arndt. Lief. 6. Pp. 449-576. 12 gold marks. Lief. 7. Pp. 577-736. 16·20 gold marks. Lief. 8. Pp. 737-880. 14 gold marks. (Berlin: Gebrüder Borntraeger, 1931.)

IN the sixth part of this work the account of the fur-bearing animals is completed. It is satisfactory to note that the colony of seals on the Pribilof Islands is increasing and comprises about a million individuals. In 1929 about forty thousand skins of this seal were collected. The order Carnivora is stated to include the largest number of species of fur-bearers and to provide the most costly skins—for example, those of the American fox, the finest examples of which from the Hudson Bay region, Labrador, and Alaska, are worth 50-400 marks each, and about 250,000 a year are sold. Of the European fox, about a million skins a year are collected; the Norwegian examples command the highest price, about 100-150 marks. The dearest fox skin is that of the silver fox, the finest specimens of which come from Labrador and have been known to realise up to 6000-8000 marks a skin.

The account of the Karakul sheep, the skin of which is known in commerce as 'Persian', includes reference to the lamb-skins of this species. The small skins, often spoken of as those of unborn lambs, are the skins of lambs the mothers of which died at or shortly after their birth. The statements that the ewes are roughly treated to cause premature birth of the lambs is definitely said to be untrue, and is unlikely, as the ewes are worth 100-150 marks and the skins of very young lambs about twenty marks each.

The number of species of animals the skins of which form an article of commerce as furs is given as about 175. Statistics of the number of pelts sold in 1928 are given for the principal countries, and show that about a hundred million rabbit skins were marketed in Europe and a similar number in Australia; in fact, that about sixty per cent of the skins coming on the market were those of the rabbit, which reached a total of 209 millions. The next in order of number were the hare, 32 millions; sheep, 30 millions; mole, 21 millions; squirrel and musk-rat, 17 millions each. The total value of the world production of rough skins in 1928 was about £77,000,000.

A chapter of twenty-four pages gives a useful summary of present knowledge and practice in the raising of fur-bearing animals, which has in recent years assumed considerable importance. The number of such farms at the end of 1929 in Germany was about five hundred, and there is corresponding development in many other countries. The principal animals reared are the silver fox, blue fox, mink, raccoon, skunk, and musk-rat—the last especially in Canada. Details of the layout and working of some of the farms are given. The spread of the musk-rat in Germany is graphically illustrated by a map which shows the rapid extension of its range between 1907 and 1924. This species has become a serious nuisance in Germany and has caused damage in central Scotland.

The seventh part and nearly the whole of the eighth part of this work are devoted to an account of the skins and feathers of birds, the orders of birds being considered in systematic sequence. The methods of treating skins and feathers to improve their appearance and to destroy the parasitic insects and mites are described, and the extent and value of the ornamental feathers and skins imported into Germany, England, and other countries are shown in statistical tables. A separate section is devoted to the skins and feathers of ostriches (there is only a relatively small trade in those of the South American rhea and a quite inconsiderable trade in those of the Australian emu and cassowary) and to ostrich farming. The difference between the number of ostriches in the Union of South Africa at the end of 1913 (776,313) and in 1926 (104,578) bears striking testimony to the influence of fashion. The

essentials of a good ostrich feather and the defects —for example, 'barring'—are noted, and statistics are added of the number and value of the feathers produced.

In the section on feathers for beds—obtained chiefly from ducks, geese, and hens, in many cases as a by-product—and on down, many details are given of their physical properties and of their preparation for their principal uses. The various uses of feather-quills and the employment of feathers and bird-skins for ornament by native peoples are described. This section concludes with a very useful summary of the species of birds the skins and feathers of which are of commercial value, with a note of their geographical distribution.

Bibliographies are appended to the principal sections, and interesting illustrations, chiefly from photographs, are placed in the text. This work presents, in concise and well-arranged form, up-to-date information, both scientific and commercial, on the skins of mammals and birds, and can be recommended as an authoritative source of reference.

Short Reviews

Die natürlichen Pflanzenfamilien: nebst ihren Gattungen und wichtigeren Arten, insbesondere den Nutzpflanzen. Begründet von A. Engler und K. Prantl. Zweite stark vermehrte und verbesserte Auflage, herausgegeben von A. Engler. Fortgesetzt von H. Harms. Band 19*a*: *Angiospermæ, Reihe Pandales.—Reihe Geraniales, Unterreihe Geraniineæ (erster Teil).* Redigiert von F. Pax. Pp. iv + 470. 60 gold marks. Band 19*c*: *Angiospermæ, Reihe Geraniales, Unterreihen Dichapetalineæ, Tricoccæ, Callitrichineæ.* Redigiert von F. Pax. Pp. iv + 251. 32 gold marks. (Leipzig: Wilhelm Engelmann, 1931.)

THE publication of the new edition of "Die natürlichen Pflanzenfamilien", which has been supervised, since the death of Engler, by Dr. H. Harms of Berlin, is progressing steadily, two volumes, namely, 19*a* and 19*c*, having appeared during 1931. Vol. 19*a* begins with the monotypic order Pandales, based on *Panda oleosa* Pierre, a West African forest tree of uncertain affinity. This is followed by ten families of Geraniales, from Oxalidaceæ to Burseraceæ respectively. More than a third of the volume is occupied by the account of the Rutaceæ, which, together with those of Zygophyllaceæ, Cneoraceæ, Simarubaceæ, and Burseraceæ, was prepared by the late Prof. Engler. The great extent of recent research on the Rutaceæ is reflected in the number of genera now recognised in that family, 145 as compared with 111 in the first edition. This is due partly to extensive generic segregation in the subfamily Aurantioideæ by Swingle and others. Both text and figures are much blacker than in the first edition, the figures in some cases—for example, *Casimiroa edulis* (p. 305)—being far too heavily shaded. Most of them, however, are very clear.

Vol. 19*c* is mainly taken up by the account of the Euphorbiaceæ, by Pax and K. Hoffmann. This great family now includes 283 genera, as compared with 209 in 1890, and the introductory matter has been thoroughly revised, now extending to 31 pages instead of 13. The necessity for a second edition is therefore obvious. In this volume also many of the illustrations—for example, *Mallotus philippinensis*—are, unfortunately, far too black.

Under the general direction of Dr. Harms, the high standard of the first edition is, on the whole, maintained.

Hume's Philosophy of Human Nature. By Prof. John Laird. Pp. x + 312. (London: Methuen and Co., Ltd., 1932.) 12*s.* 6*d.* net.

HUME becomes more and more popular among philosophers. The reason is that we find ourselves in a period very similar to his. Indeed, it is felt that the dogmatic interpretations which have been given of the momentous discoveries of our time are not quite satisfactory in themselves. Before proceeding to the formulation of new theories, it appears necessary to clear the ground, which implies primarily the action of a sceptic mind. It is quite natural, then, that philosophers should turn for inspiration and encouragement to David Hume, the father of modern scepticism.

Though Hume was versed neither in mathematics nor in natural science, the critical examination he made of their theoretical presuppositions is a permanent addition to our philosophical knowledge. His great contribution to the discussion is his distinction between 'knowledge' and 'probability', which is at the basis of inductive inference.

Prof. Laird explains and examines Hume's principles of causal inference in Chap. iv., perhaps the most important of his book. There we find a remarkable discussion of questions such as the uniformity of Nature, belief, testimony, conjectural probability, analogy, and experimental method, where Hume anticipates many considerations which we find later in Stuart Mill's "System of Logic". One of Hume's most peculiar principles is that which denies plurality of causes and plurality of effects, though it may be doubted whether he was entitled to hold it without any decisive arguments. In his chapter about "Space, Time, and External Existence", Prof. Laird discusses also many interesting doctrines of Hume's bearing on the foundations of mathematics. His long acquaintance with Hume's system has made Prof. Laird one of the safest guides to the complexities of his philosophy; and the book he has produced is a permanent addition to the philosophical literature of the day.

Volumetric Analysis. By G. Fowles. Pp. xii + 202. (London: G. Bell and Sons, Ltd., 1932.) 6*s.*

THIS book will be welcomed by teachers of chemistry who are desirous of placing in the hands of their students a lucid exposition of up-to-date methods of volumetric analysis. Although intended for uni-

versity students and candidates for university scholarships and the National Certificate in Chemistry, the book contains much matter which will be of interest to many chemists.

Mr. Fowles has been at considerable pains to expound the principles upon which volumetric analysis is based, so that in carrying out the determinations the student will be consciously applying these principles and not merely performing a set of experiments without regard to the physico-chemical theories involved.

The first two chapters are devoted to general principles, and include much information on equivalents, indicators, calibration, and the selection of substances as standards. The next four chapters deal with the various methods of volumetric determinations—neutralisation, in which the theory of indicators is discussed; oxidation by permanganate, dichromate, bromate, and iodate; reduction by titanous sulphate; iodometry; and precipitation. The final chapter takes the form of a synopsis, and contains the volumetric processes for the estimation of all common metals, acid radicals, and many organic compounds.

Embodying, as this book does, the recent advances in volumetric analysis, it is a very useful addition to chemical literature.

Why we Oppose the Occult. By Prof. Émile Cailliet. Translated by Prof. G. F. Cole. Pp. v + 200. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1931.) 8*s.* 6*d.* net.

To the modern mind the very word 'magic' stands for an idea which is little short of degrading. Yet we have to remember that, according to high authorities, magic was the real foundation of religion, the most divine creeds having belief in magic as their basis. Furthermore, the ancient Oriental magicians passed on their accumulated observations to the Greeks, enabling the latter to lay the foundations of mathematics, so that magic may be said to be the origin of science—of science through the intermediary of religion, as Frazer shows. But societies which thus owe so much to magic not only free themselves from it, but also vigorously reject it, turning from the occult with disgust. In our own day the occult is the object, not merely of disbelief, but also of active opposition and ridicule. Why? That is the problem to which Prof. Cailliet addresses himself in this book, with many examples drawn from his intimate knowledge of beliefs and practices in Madagascar.

Physics: Fundamental Laws and Principles with Problems and Worked Solutions. By Edgar Booth and Phyllis M. Nicol. Pp. 648. (Glebe, N.S.W.: Australasian Medical Publishing Co., Ltd., 1932.) n.p.

THIS volume, which is of a good intermediate standard, is divided into two main sections. The first part consists of thirty-six chapters, and expounds the fundamental principles and laws of physics in a series of clear statements which are driven home by means of a large number of illustrative problems, of a mixed bookwork and rider type.

The second part consists of answers to and worked solutions of the problems given in the first part.

The whole book bears evidence of much care and thought in its preparation; it should prove a useful aid in testing and co-ordinating the knowledge of a student of elementary physics.

The Doctor Explains. By Ralph H. Major. Pp. xvi + 277 + 27 plates. (London: Chapman and Hall, Ltd., 1932.) 15*s.* net.

IT would be difficult to present a more interesting and comprehensive account of progressive medical science and practice than that covered by this book. The author succeeds brilliantly in his endeavour to explain in untechnical language how the methods of treatment and diagnosis employed by modern physicians and surgeons are the results of research in many scientific fields, and his work should do much to promote intelligent interest in the preventive as well as the curative services of medicine. The book is an inspiring record of human thought and action towards the conquest of disease, and it will be read with both profit and pleasure not only by the laity but also by many general medical practitioners.

Hippokratesglossare. Von Max Wellmann. (Quellen und Studien zur Geschichte der Naturwissenschaften und der Medizin, herausgegeben vom Institut für Geschichte der Medizin und der Naturwissenschaften, redigiert von P. Diepgen und J. Ruska, Band 2.) Pp. iv + 88. (Berlin: Julius Springer, 1931.) 16 gold marks.

THIS learned memoir is a valuable addition to the history of the sources of the Hippocratic commentators. The main point of its author is that Erotian, who wrote a glossary on the Hippocratic works during Nero's reign, was not a grammarian, but a physician. Then he goes on to discuss the sources of Erotian, and to compare previous glossaries of the Hippocratic works with them. The glossary of Bakcheios, who published the first edition of the Hippocratic works, was superseded later by the commentaries of Glaukias, Epikles, Heraclides of Tarentum, and Euphorion the Grammarian.

Die lichtelektrische Zelle und ihre Herstellung. Von Dr. Richard Fleischer und Dr. Horst Teichmann. Mit einer Einführung von Prof. Dr. H. Dember. (*Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe*, herausgegeben von Dr. Raphael Ed. Liesegang, Band 27.) Pp. xii + 175. (Dresden und Leipzig: Theodor Steinkopff, 1932.) 12 gold marks.

THIS unpretentious little volume gives, in compact and handy form, a very clear conspectus of the properties and methods of production of light-sensitive cells. It is well produced and illustrated, and its usefulness is enhanced by a critical bibliography of some 230 entries, ranging over the years 1877–1931.

Physical and Observational Evidence for the Expanding Universe

By J. H. REYNOLDS

SO much has been written in recent years on the subject of the expanding universe from the theoretical point of view, that there is no need here to give more than a summary of the position, following Sir Arthur Eddington. The 'Einstein universe' was a conception based on a static solution of Einstein's field equations in which matter was distributed with uniform density, filling a closed space, and in equilibrium owing to the balancing of gravitational attraction and cosmical repulsion. In 1917, Prof. W. de Sitter, of Leyden, put forward his now famous hypothesis, predicting large velocities of recession for distant objects, which was based on a small modification of Einstein's equations. The difficulty about the 'De Sitter universe' was that it was empty, so that the cosmical repulsion acted without hindrance.

The discovery, mainly owing to V. M. Slipher, that the line shifts in the spectra of the spiral nebulæ were large and predominantly towards the longer wave-lengths, lent a considerable measure of support to de Sitter's theory, but obviously the universe was not empty of matter, and some other intermediate solution had to be sought. Such a solution was found ultimately by Abbé G. Lemaître in 1927, although its importance was overlooked until de Sitter and Eddington directed attention to it in 1930. They realised at once that a non-static solution of the Einstein equations was possible, so that an expanding or contracting universe was inevitable from Einstein's law of gravitation. The question whether contraction or expansion would best agree with the conditions actually existing was considered settled by the observed displacements of the nebular absorption lines towards the longer wave-lengths, which on the Doppler principle would be interpreted as measures of velocities of recession.

The observational evidence required to establish the hypothesis, and to evaluate the expansion factor, lay in two separate series of data: (1) an adequate number of measured spectra of the extra-galactic nebulæ with as wide a range of systems as possible, and (2) a trustworthy scale of distances for these systems.

RADIAL VELOCITIES DERIVED FROM THE LINE DISPLACEMENTS IN THE SPECTRA

From the instrumental point of view, the difficulties of securing satisfactory spectra for measurement were at first considerable. The spectrographs employed for stellar work and for galactic nebulæ giving bright line spectra proved quite inadequate to deal with the faint continuous spectrum of the extra-galactic spiral and elliptical nebulæ, even with prolonged exposures.

The obvious remedy was to reduce the dispersion, although this made wave-length measures more uncertain, and it was not until a scale of about 100 A. to the millimetre was adopted that satisfactory densities were obtained, with exposures from twenty to thirty hours spread over several nights.

The type of spectrum of the extra-galactic nebulæ was found in general to be very similar to the solar spectrum, the principle lines being the *H* and *K* lines of calcium, and the *G* group, with some traces of the hydrogen lines, all appearing as wide and shallow absorption lines on a continuous spectrum.

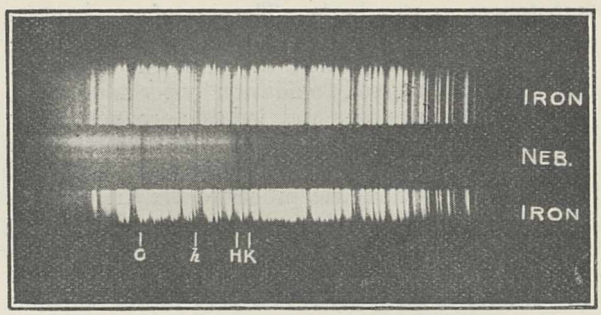

FIG. 1.—Dark-line spectrum of nebula M 81 (N.G.C. 3031) by M. Wolf, Heidelberg.

The first list of forty measured spectra was issued by V. M. Slipher about ten years ago. Among these a small group, including the Andromeda Nebula and M. 33 (the two spirals of largest angular size in the sky and probably the nearest) were found to have large displacements towards the shorter wave-lengths, and therefore considerable velocities of approach. These, with one exception, were all in the south galactic hemisphere in the same region of the sky.

On the face of it, this seemed to raise a serious difficulty, for, according to the hypothesis, it was impossible to have expansion and contraction existing together. The discovery later of the rotation of the galaxy by Dr. Oort, and its subsequent confirmation, furnished a simple explanation of these negative velocities, as the term introduced was a large one, about 280 km./sec., and in the right direction. At the same time, it is as well to state that considerable discrepancies have occurred in the measures of the nearer as well as the farther nebulæ. As an example of this, the first measures of the radial velocities of the Andromeda Nebula and M. 33 gave values of −300 km./sec. and −260 km./sec. respectively, while the latest measures of these two spirals give much smaller values, namely, −220 km./sec. and −70 km./sec.

If the galactic rotation is responsible for these velocities of approach in the south galactic hemisphere, one would expect a similar effect on the nearer spirals of large apparent angular diameter in the north galactic hemisphere, so long as they are similarly situated in galactic latitude and longitude. There are two objects which conform to these conditions, M. 81 (N.G.C. 3031) and N.G.C. 2403. The velocity shift of the first has been measured and is of the right order, −30 km./sec. N.G.C. 2403,

which should show a much larger negative velocity from its position, has not yet been included in the lists of radial velocities.

Since 1928 the question of line displacements has been taken up at Mount Wilson by Hubble and Humason, and the number of known displacements very greatly extended by the inclusion of fainter, smaller, and more distant objects. Special spectro-

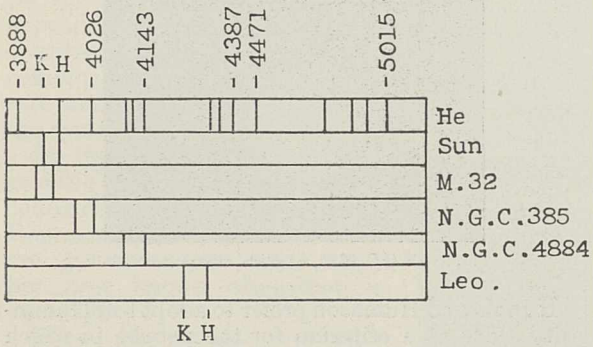

FIG. 2.—Measured displacements of the *H* and *K* lines.

graphic apparatus had to be contrived for dealing with these faint nebular images in the 100-in. reflector. For some of the previous work a dispersion of 170 A. per millimetre was found to be concentrated enough, but this was replaced by a dispersion of 340 A. per millimetre.

In its turn, this also was discarded for an even smaller dispersion for very faint nebulæ. With a spectrograph objective of F/0·6 designed by Dr. W. B. Rayton, two prisms gave a dispersion of about 418 A. per millimetre at λ4500, and one prism 875 A. per millimetre. The uncertainty of the result with the last-named is claimed to be not greater than 300 km./sec., which is small compared with the line displacements. The highest velocity yet measured was found in a cluster of small elliptical nebulæ in Leo, where the displacement in the brightest member was equivalent to the stupendous rate of +19,700 km./sec.

The small scale of the spectrum is naturally a disadvantage so far as measurement is concerned, but a well-defined comparison spectrum of helium above and below the nebular spectrum gave a series of wave-length positions quite accurate enough for the purpose.

THE DISTANCES OF THE EXTRA-GALACTIC NEBULÆ

The great difficulty in correlating the radial velocities derived from the spectra with distance has been the lack of a definite scale of distances. Until a few years ago, even the order of distance was only a matter of conjecture, but the discovery by Hubble of Cepheid variables in the outer regions of the Andromeda Nebula gave at last a basis for a definite estimate of the distance of this system.

The previous work of Shapley and others had shown that a relationship existed between the absolute magnitude of these stars and their period. Those of short periods of a day or less are of considerably less intrinsic brilliancy than those of much longer period. All the Cepheids found by Hubble were of the longer periods, corresponding to the stars of greater absolute magnitude, those of shorter period being presumably too faint to be detected. As a first approximation the distance of the Andromeda Nebula was determined as a million light-years, and a similar investigation of M. 33, a neighbouring formation in the sky containing well-defined masses of stars, led to a slightly less distance. The Cepheid variables are undoubtedly the most reliable guide to distances, but there are other types of stars to which absolute magnitudes can be assigned within wider limits. Such are O type stars of very high surface temperatures, B type of temperatures of about 15,000 C., novæ which have occurred from time to time in the nuclear regions, and others. These were also found to exist in the two nebulæ mentioned. Linked up with the Cepheids they gave a reasonably consistent result. Estimates of these and other spiral and elliptical nebulæ were also made by Lundmark of Uppsala and agreed in general with those obtained by Hubble.

Later a list of the eight nearest nebulæ was compiled by Hubble, based on magnitude observations

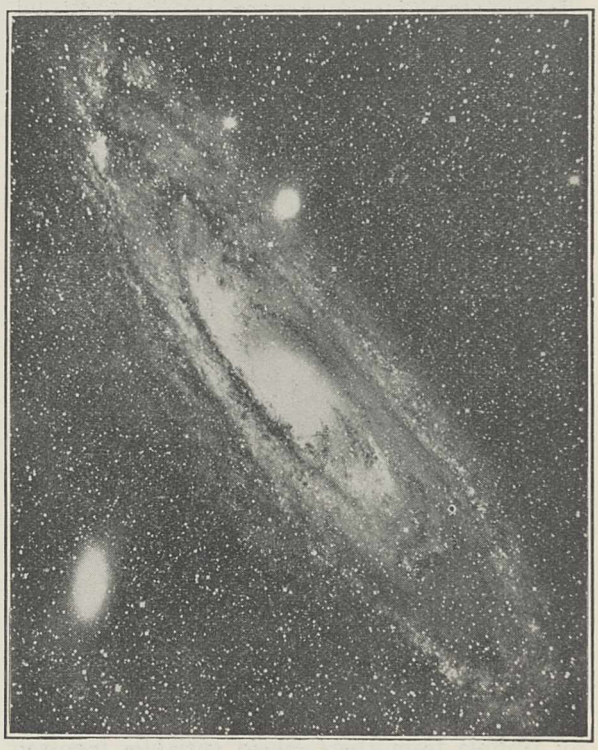

FIG. 3.—The Great Nebula (M 31) in Andromeda.

of involved stars of known types and including the two Magellanic Clouds which were regarded as irregular extra-galactic nebulæ.

For more distant nebulæ in which faint stars were actually detected but the types of which were unknown, Hubble adopted the principle that there is an upper limit to intrinsic stellar luminosity, and that observed differences in magnitude of these faint stars in various nebulæ give a rough guide to differences in distance.

Unfortunately, discrete star discs can be more easily detected in the condensed or later type of spiral than those having an amorphous bright nucleus and a varying amount of outer condensation. Out of a total of 31 nebulæ of the type of the Andromeda Nebula, 19 gave negative results, while out of 30 of the condensed type of M. 101, 22 gave positive results. This means that for two objects of different types, comparable so far as diameter and distance are concerned, one would probably show star discs and the other would not.

Some other criterion, therefore, had to be adopted. The most obvious was the angular diameter, which on the average would vary directly in inverse ratio to the distance for any particular class of nebulæ.

The difficulty of getting a reliable scale of distances, either by the integrated light of the nebulæ or the diameters, is very well exemplified by taking the two spirals of largest angular diameter in the sky—M. 33 and the Andromeda Nebula (M. 31). The distances of both have been well determined

FIG. 4.—Spiral nebula M 33 photographed with 60 in. reflector at Mount Wilson.

by Hubble from the Cepheid variables involved, and come out as follows :

	Distance in 10^5 parsecs.	Diameter.	Estimated Visual Integrated Magnitude.
M 33	2·36	80′	7
M 31	2·47	140′	5

(One parsec = 3·259 light years.)

M. 31 is thus more than half as large again in angular diameter, and its total integrated light six times that of M 33, yet it is actually more distant, although the difference is comparatively small.

Of course, if a great number of nebulæ of either the spiral or elliptical type are taken, the diameter and integrated luminosity together would give a rough scale of distances, but the distances of particular objects might be out by as much as 40 per cent.

FIG. 5.—N.G.C. 3379, a typical elliptical nebula.

Hubble and Humason prefer to adopt total luminosity alone as a criterion for the nebulæ in which no stars are visible, on the ground that while increased exposure systematically extends the linear dimensions on the plate up to a superior limit, the percentage of increased diameter is much greater than the percentage of total luminosity, as there is normally a great concentration of luminosity in the nuclear regions. But in any event, it is obvious that the great trouble in arriving at a satisfactory scale of distances is the lack of homogeneity in the observational material. Even for the same objects the integrated luminosity obtained by photographic out-of-focus images differed by as much as three magnitudes in the results obtained at Mount Wilson and Harvard respectively. In the clusters of elliptical nebulæ, which must be of the same order of distance, there is a range of four magnitudes between the brightest and the faintest, so here integrated luminosities would be anything but a sure guide.

Correlation of Radial Velocities and Distances

Notwithstanding the unsatisfactory nature of the scale of distances, Hubble established in 1929 that there is a general correlation between radial velocities and distances of something like 500 km./sec. per million parsecs. The following lists give some typical examples :

Estimated Distances and Equivalent Radial Velocities of the Eight Nearest Known Systems

System.	*R.*	*V.*	*L.*	*B.*
Nubecula Major .	0·262	+170	245°	− 35°
Nubecula Minor .	0·290	+290	265	− 40
N.G.C. 6822 . .	1·92	− 130	350	− 19
M. 33 . . .	2·36	− 70	101	− 31
M. 31 . . .	2·47	− 185	87	− 22
M. 101 . . .	4·0	+200	116	+58
N.G.C. 2403 . .	6·3	..	62	+28
M. 81 . . .	7·3	− 30	107	+39

R. = distance in parsecs × 10^5.
V. = equivalent velocity displacement.
L. = Galactic Longitude.
B. = Galactic Latitude.

The distances given here are based on the Cepheid variables, except the two last, where stars of other types are used as gauges.

The solar galactic rotation effect, found by Hubble to be about 280 km./sec. with its apex in galactic longitude 32° and latitude +18°, introduces large corrections in most of the above. Taking this into account, all the negative velocities disappear, and we are left with a quantity which represents a combination of the expansion rate and the peculiar motion of the system.

In the next table the solar galactic rotation effect is smaller compared with the velocities. Representative systems only are given, as the total number now known altogether is over eighty.

Here the radial velocities have already been corrected for the galactic rotation.

The distances have been estimated from involved stars of the 18th magnitude and fainter, the types of which are unknown. These stars are taken as representatives of maximum intrinsic luminosities.

System.	*R.*	V_0.	*Mn.*	*Ms.*
N.G.C. 5236 .	0·9	+500	10·4	18·5
3627 .	0·9	+850	9·1	18·5
1068 .	1·0	+920	9·1	18·7
7331 .	1·1	+500	10·4	19·0
4258 .	1·4	+500	8·7	19·5
4151 .	1·7	+960	12·0	20·0

Mn = integrated nebular luminosities.
Ms = stellar magnitudes.

Past this point stars are no longer available as criteria of the more distant systems, so reliance has been placed by Hubble on the integrated visual or photographic magnitudes of the nebulæ themselves. If we take a hypothetical nebula of average total intrinsic luminosity and imagine it removed to twice the distance, its diameter would of course be halved and its total luminosity reduced to a quarter.

As the ratio between one stellar magnitude and the next is 2·512, it follows that a decrease in luminosity of one magnitude would be equal to an increase of distance by 1·58. This is therefore the equivalent ratio in the following table, where integrated magnitudes take the place of estimated distances. Large discrepancies are inevitable in such a procedure, as the results show.

As a final test of the validity of the expansion factor for very distant objects, Hubble and Humason examined certain of the brighter nebulæ which appear in isolated groups. The great majority of these are of the small elliptical type, showing no spiral structure. Some nebulæ in the Virgo group, which would perhaps be better described as a concentration in the line of sight, gave largely different velocities, but the general results were such as to give ample support to the expansion hypothesis.

From the data given, Hubble and Humason adopt a round figure of 560 km./sec. per million parsecs as the velocity-distance relation. Although the whole investigation was necessarily based on indeterminate and to some extent arbitrarily selected material, the relation seems to be a reality. The velocity ratio found can scarcely be regarded yet as more than a first approximation, but it is of the right order.

FIG. 6.—Field of elliptical nebulæ by 100-in. reflector at Mount Wilson. R.A. 3 h. 12 m. Decl. +41° 6′ (Perseus).

System.	V_0 (corrected for solar motion).	Mag. Vis. or Phot.
N.G.C. 4051	740	11·9
3227	1090	12·0
7217	1250	12·3
2859	1450	11·1
2950	1560	11·6
3010	1950	11·8
6703	2280	13·6
6702	2530	14·6
6359	3250	14·3
6661	4170	14
6710	5380	15

Group.	Number.	Range of V_0 km./sec.	Mean Photr. Integrated Magnitude.
Virgo . .	7	600-1170	12·5
Pegasus . .	5	3500-4000	15·5
Pisces . .	4	4460-4960	15·4
Cancer . .	2	4670-4970	16·0
Perseus . .	4	4800-5800	16·4
Coma . .	4	5100-8000	17·0
Ursa Major (Baade 24)	1	11800	18·0
Leo . . .	1	19600	19·0

A question has been raised as to the proper interpretation of the observed displacements of the

spectral lines. Is the Doppler effect the only possible interpretation? If the slowing down of light over vast distances is a possibility, shifts towards the red would be expected—indeed, de Sitter's original cosmology suggested this as alternative or complementary.

A letter to NATURE of Jan. 16, 1932, from Prof. W. D. MacMillan, suggests that the red shift is due to loss of energy in the photon in course of time, due either to inherent instability or collisions with other photons. He concludes: "Such an interpretation of the extraordinary shifts that are observed will be more acceptable to many than an interpretation which makes our galaxy a centre from which all others are fleeing with speeds that are proportional to the distances".

Canons of Archæological Theory*

By Dr. DAVID RANDALL-MACIVER

FROM a vast and intricate subject I will select for discussion only two of the principal problems of archæology—namely, the application of a time-scale and the proof of the dissemination of a culture. First, then, as to the time-scale. A series of culture periods has been well established, so that there is a reliable system of what is called 'relative chronology' from the earliest Stone Age down to the time of full documentary history. But it is a very different matter when we attempt to translate these culture periods into centuries and thousands of years. We are wholly dependent for our absolute chronology upon the dates recorded or obtained by immediate inference from ancient writings or traditions. The fragmentary relics of Mesopotamian and Egyptian official chronology furnish a time-scale, liable to much uncertainty in minor details, but trustworthy in all its main lines. As archæological discovery proceeds in the coming years, we may reasonably hope to arrive at a completely graduated scale of chronological dating in actual years for every part of the ancient world after 3500 B.C. But if it is asked what means we have for establishing a chronological as well as a typological scheme behind 3500 or possibly 4000 B.C., I answer unhesitatingly that we have none, and that unless earlier written records or traditions come to light it is probable that we shall never have any.

One very crude method of attempting to avoid this impasse is so illogical that I need spend little time in discussing it. Below the strata in which definitely datable objects are found—whether at Knossos, Ur, Susa, Mohendjodaro, or any other very ancient site—there are generally strata of a certain thickness in which other and obviously earlier forms occur. Now, it is sometimes suggested, even by skilled explorers in their less discreet moments, that the mere thickness of these undated layers may give an indication of the length of time which it took to form them. Yet a very slight amount of reflection, not to speak of actual experience in the field, will show that this reasoning is as childish as it is simple. I have myself seen in Egypt deposits many feet deep which can, nevertheless, be proved, by well-dated objects at the top and bottom, to have been formed within a single century; and I have also seen a concentrated stratum of not more than four feet which contained the products of many centuries closely pressed together.

In a less crude but not very different form, the same error appears in the attempt made by several justly admired writers to establish a chronological scale for the typological series preceding the historical in a country like Egypt. The system of sequence-dating based on typology is now familiar to all students. It was established for Egypt by Sir Flinders Petrie, and for Europe in general by Montelius. As a scheme of relative chronology it sometimes creaks a little, but on the whole it works well and has justified itself, though it may need occasional emendation. But the recurring attempts made by one author after another to translate this relative system into an absolute chronology of years have no logical justification whatsoever, and only encourage self-deception.

The argument is really based on an assumption which can easily be shown to be fallacious. This is the assumption that the rate of progress in civilisation is always uniform. If we know the rate of development in types which took place during the First and Second Dynasties and know also from inscriptions the length of these dynasties, then, it is argued, we have a yard-stick which can be applied to the period preceding the First and Second Dynasties. It is as though a policeman, having timed a speeding motor car over a measured mile, and found that it was going at sixty miles an hour, should appear before the magistrate and state that it was evident the defendant had been proceeding all day at sixty miles an hour.

If, however, we must abandon such illegitimate methods, it is not quite impossible that properly directed ingenuity may find some others which will give a rough scale, less accurate indeed than the chronological, but, nevertheless, valuable. The recent success of Miss Caton-Thompson in settling the very difficult dating of Badarian culture by truly logical methods based on geology is very encouraging; and thirty years ago I myself made a suggestion which I still think has some value. If, I suggested, we could discover the village corresponding to an ancient cemetery, and also ascertain the total number of burials in that cemetery, then we should be able by calculating the presumable death-rate to arrive at a rough estimate of the number of generations. It is evident that several factors in this equation can never be established more than approximately, but it would be worth attempting, if ever a suitable site could be found.

Next we may briefly consider the problem of the dissemination of cultures. This is really the cardinal

* From the presidential address to Section H (Anthropology) of the British Association, entitled "The Place of Archæology as a Science, and Some Practical Problems in its Development", delivered at York on Sept. 2.

problem of archæology, irresistibly attractive, and for that very reason offering peculiar temptations to hasty and premature generalisation.

Now, the foundations of this particular study, in so far as they have been well and truly laid at all, have been laid not by archæology but by other sciences, those in fact which deal not with man himself but with the conditions necessary to his very existence. Geology, climatology, palæontology, palæobotany have been the instruments of that great progress in synthetic theory which I have pointed out as the special achievement of the last thirty or forty years. Those who have worked out the details and the stages of the Ice Age and the rainy periods have shown us that various parts of the world were uninhabitable for a long time. It is obvious, for example, that man cannot exist under a snowfield, so that it is useless to look for him north of lat. 50° until the Ice Age is well past.

Conversely, large areas which to the modern view seem impossible homes for man are shown to have been eminently suitable for the life of the palæolithic hunter. The Sahara and the Gobi desert in their present condition cannot maintain the life of man or beast; but the climatologist shows that there was a not very remote period when they were well-watered regions, covered with grass like the South African veldt, and teeming with large game. Thus he explains what otherwise might have remained an ambiguous problem for the archæologist, the finding of human implements of very early types in these apparently uninhabitable tracts.

The botanist next comes forward to tell us that the food plants on which a settled agricultural life depends can only be found in their wild state in certain closely defined areas. He also shows how changes of climate produce various types of afforestation which necessarily limit the movements and activities of a man who possesses only primitive tools.

But when the archæologist proceeds by purely archæological methods to fill in the details on a background of which the outlines are thus immutably drawn by the other sciences, he is confronted with innumerable difficulties of method, and the logic of his procedure is not always well studied. In the first place, we must necessarily rule out many types of reasoning which are so general and inconclusive that they can never carry any conviction. A little serious reflection must show that we necessarily know so little of the mental equipment of early man that it is often impossible to say what actions and habits are natural to all men as highly developed anthropoids, and what are so peculiar as to be specifically human and characteristic of one or another developed type of man.

That man should seek shelter from the elements is so obviously natural, and so like all other animals, that probably no one would argue that the living in caves or the construction of a primitive shelter, analogous to an animal's lair or a bird's nest, must presuppose any identity of race or origin. Or again, may not any animal pile up stones? And if so, at what exact stage does the piling up of stones become such a complex action that it can only be developed in one place? Suppose that a shelter of stones has to be roofed. Is the laying of slabs, one overlapping the other so as to form a corbel, so intricate a device that it might not be invented in many places simultaneously? It seems a very primitive process, even if it has been developed with great skill in certain countries.

It has sometimes been suggested that the discovery of the uses of burned clay, and consequently of baked pottery, may have been due to the accidental firing of a wattled hut. If so, it is difficult to maintain that the invention of pottery could only happen in one place, unless the use of fire was limited to one little spot on the earth.

These apparently elementary questions go to the root of the whole matter. Whatever answer an archæologist might give, he could not persuade by logical means any opponent who chose to disagree with him. He would be obliged, when driven into a corner, to say, "I am convinced" of this or that, but the conviction would express nothing more than his own temperament and psychology.

To apply logic at all, then, we need to find our material in highly specialised products or habits of man. In short, it is only possible to reason convincingly when manufactures or arts and crafts have reached a high point of intricacy. Let us take examples from flint-working, man's earliest craft. It seems fair to say that the use of natural flints, perhaps even of pre-Chellian or rostrocarinate and other forms which involve the minimum of workmanship, might arise independently among various types of almost simian man. But when it comes to elaborate chipping, and when this chipping produces implements of identical and highly specialised forms, then it is indeed logical to argue that this process and these forms could only have been invented once and only in one region. Chellian flints already seem to me to be so distinctly a product of a highly specialised intelligence, which might have taken a hundred other forms, that it must inevitably be inferred that a single type of man originated these artefacts, even though they are found distributed over an immense area.

Still more it might be supposed that when one more degree of elaboration has been added, by the use of so peculiar a technique as pressing off flakes as well as chipping, the logical inference was still stronger. If, further, this peculiar technique is combined with peculiar shapes, then the case seems to be almost irresistible. To accept this would entail some surprising consequences, linking, for example, the Badarian culture of earliest Egypt with the Solutrean of Europe and perhaps with other even remoter places. Yet it is certainly good reasoning. It is curiously significant, however, of the difficulty of arriving at any certain conclusions that just as we might be ready to accept this theory of the Solutrean, with all its far-reaching consequences, Menghin comes forward with the assertion that the Solutrean style is the natural and inevitable product of the juxtaposition of a core-working and a flake-working industry.

In contrast to the doubts and uncertainties which beset all reasoning based on the manufactures and

products of early man, it is a relief to turn to a field in which unquestionable logical certainty can be achieved. This is when we are able to study man's action in moving and displacing natural products. For when the natural distribution, as known to geologists, of rocks, ores, and other natural products is artificially changed, there can be no doubt that man has been at work. Thus, if a certain kind of flint is peculiar to Grand Pressigny in France and implements of that flint are found in Switzerland, there can be no doubt that Switzerland is trading with Pressigny. Similarly, if gold combined with antimony is known only to occur in Transylvania, it is a just, though a surprising, inference that the sceptre of a very early Egyptian king, living about 3000 B.C., which shows this unique combination of metals, is made of gold from Transylvania. To take a simple example from nearer home : if a number of stones in the circles of Stonehenge are of a type peculiar to Wales, they must have been transferred from Pembrokeshire to Salisbury Plain by man.

Raw materials, then, are better evidence than manufactures, especially in the earlier stages of man's life. When we are dealing with the works of man, logical processes of real value only begin to be applicable as handicrafts become more complicated and as the arts begin to emerge. Between art-styles, if we are sufficiently discriminating, it is possible to institute sound contrasts and comparisons. To take an extreme example, we should no doubt recognise a Greek statue even if it were found in West Africa. The hammer-axes of Troy and the Danube, the polygonal battle-axes so widely spread over southern Russia and northern Europe, the lunulæ of Irish gold, the decorated situlæ of Iron Age Italy, the painted vases of pre-Corinthian style, may stand as examples of highly specialised products which unquestionably denote commerce and reciprocal influence wherever they occur.

We have to be on our guard, however, against many cases in which the style is scarcely developed enough to be a convincing criterion, or in which the style has become so confused owing to cross influences that it gives an ambiguous answer. Most of all does this occur in the sphere of pottery. There is more bad reasoning in regard to pottery than in regard to any other part of our subject.

Especially in such early stages as the Neolithic and the Chalcolithic, there is the same danger of reasoning in too general terms that I have already pointed out in regard to primitive customs and habits. The smaller vessels used during the Neolithic stage are all imitations in clay of receptacles originally made in other materials. Goatskins, leather bags, gourds, and baskets are some of the natural predecessors of pots. It is only to be expected, therefore, that the clay imitations of these will be found far and wide among people who may have had no racial connexion or commercial intercourse of any kind. It is only occasionally that geographical conditions may intervene to prove that there is a real unity of culture underlying the superficial resemblances. There is, however, one happy instance of this. Gourds are indigenous in tropical and semi-tropical countries, but do not grow naturally in Europe. When, therefore, pots derived from gourd-forms are found in Moravia, it is a logical and necessary inference that the people who made them on the Danube came from a gourd-producing country like Asia Minor, or were in close commercial relation with it.

In this connexion, I should like to contrast two examples of reasoning, one of which has led to useful and fruitful results, while the other threatens to plunge us into confusion. All archæologists are agreed that the beakers which have such a wide distribution over Europe in the Bronze Age are derived from a single source, though they are not unanimous as to the centre of origin. This unification of a single system all over the west and north of Europe, including Great Britain, has greatly assisted the study of the Bronze Age in those regions. But contrast with this the attempts which are being made to unify the schools of painted pottery so as to make a chain from Chalcolithic Sicily to China. The dates are hopelessly incompatible over large sections of this immense area, the civilisations have few if any points in common, and yet we are invited to unify them on the sole basis of paint being used. It is even asserted in so many words that it is improbable that the idea of applying paint to pottery should arise independently in different centres. It might be too dogmatic to say that this is utterly illogical, but it can certainly be said that it is quite unconvincing. The discovery of paint is in itself easy and inevitable, and once this medium is known, it will naturally be used for anything and everything.

This leads me to make, in conclusion, the only suggestion that I think need be made in regard to the training of the young archæologists of the coming generation. I do not believe that early specialisation in archæological training would be wholesome—indeed, I think it would probably be rather harmful. As I mentally call over the roll of my most distinguished colleagues, some a little older and some a little younger than myself, I am struck with the remarkable diversity of their background and training. This diversity has probably been a real source of strength. That classical scholars, historians, anthropologists, geologists, lawyers, engineers, artists, and many other types of mind should focus from different angles on the same subjects has led to catholicity and breadth. For it is not so important that an archæologist should be an expert in one subject as that he should be widely and well educated.

With this premise once granted, I think that much time would be saved, and much efficiency would be added, if the student at the beginning of his archæological career were to superimpose a year or so of intensive technological training on his more general education. We all know the saying that a man does not really know about an object until he can make it. A technical training in primitive handicrafts such as pottery-making, flint-chipping, weaving, and the hammering, alloying, and casting of metals, would give him an insight which no mere reading or even handling of finished specimens can give.

Obituary

SIR RONALD ROSS, K.C.B., K.C.M.G., F.R.S.

RONALD ROSS'S great discovery was made so long ago that it is difficult for anyone, unless he is nearer sixty than fifty years of age, to remember either the baffling mystery of malaria or the flood of light which his discovery threw not only on malaria, or even on tropical diseases generally, but also on all disease. His discovery disclosed conclusively a new method of the transmission of disease ; and its practical importance was immediately recognised, as Great Britain was beginning to understand how vital it was to minimise the wastage of life involved in maintaining her Empire overseas.

Ross stated himself that it was about 1889 when he began to take his profession seriously, and he was specially attracted to the fever cases that mainly filled his hospital. As he had not heard of the work of Marchiafava, Celli, or Golgi, it is perhaps not surprising that he was unable to recognise the bodies described by Laveran. But a visit to London in 1894 brought him into contact with that other great figure in tropical medicine, Patrick Manson. Manson knew all that was to be known about malaria parasites at that time, and his penetrating mind had already decided that, in some way or another, the mosquito was the agent by which the disease passed from one man to another. Nor were his speculations merely the dreams of an idler, sitting in a comfortable arm-chair. Manson had worked in China and had there discovered two phenomena : the nocturnal appearance of the embryo of *Filaria bancrofti* in the blood of man, and the shedding of its sheath when the blood was cooled. He had wondered what all this meant. Had it any bearing on the life-history of the parasite ? He had realised that this disease could not be spread by direct contact, and that some special mechanism was required to assist the parasite's escape from the human body. He rightly inferred that the mosquito was the most likely means by which that occurred. He reasoned that when the mosquito sucked blood from man, the parasites would be sucked in too, and that after living in the mosquito during its lifetime, they would escape on its death into water, from which they would again reach the body of man by ingestion.

Manson forthwith put his ideas to the test, for he was a man of action ; and he saw things that convinced him that he was right. Men might tap their heads and suggest that Manson was mad in some of his ideas. I am sure he only smiled at that, for he had seen with his own eyes something that could have only one meaning, namely, that the parasites had found a congenial abode outside of man, and were growing in the mosquito. With this firmly fixed in his mind when he began to work on malaria in London, and when he saw certain strangely moving forms, he concluded that these were not due to the convulsions of a dying parasite, but were the beginnings of a new life cycle which would be spent partly in the mosquito, partly in water, and ultimately in man.

Manson told all these things to Ross ; and it was decided that Ross should begin his investigation with the crescent form of parasite and try to follow the flagellum, that curious writhing thread which bursts from the crescent some time after blood has been drawn from man.

As it turned out, however, although the flagellum was the new phase of the parasite's life outside its human host, it was practically useless as a clue to the discovery of the secret. "Follow the flagellum" was Manson's advice ; but the flagellum absolutely and utterly disappeared soon after it entered the mosquito's stomach, and it could be found neither in the stomach nor in any other tissue or organ of the insect. It is here that the genius of the younger man came to the aid of that of the older. For Ross had the perseverance that is required to make a great discovery, and he had the eye and mind to recognise the malaria parasite when it presented itself, strangely disguised, in the wall of the mosquito's stomach.

For nearly two years Ross hunted for the elusive thread. He dissected, he stated, more than a thousand mosquitoes, going through every possible tissue, and working out a technique that finally laid bare the parasite. What neither Ross nor Manson knew was that only a few species of anopheles carry malaria, and that in many parts of the tropics, India included, the number of the dangerous species is a very small percentage ; indeed, in many places, only a fraction of one per cent of the total number of mosquitoes that buzz around and bite a man. But at last came the day when Ross had a new species of mosquito to feed. He bred it from a new kind of larva. He kept it in captivity, and he pictured in his notes the egg of the insect, which is clearly that of an anopheles. He fed it on a malarial patient ; a few days later he dissected out the stomach of the mosquito by his own special technique, and there lay the malaria parasite—a tiny thing, but to the searcher's eye the thing he had sought so long and so patiently—indubitably the thing, for it had the fine grains of

pigment that the parasite in human blood contains. He had triumphed over the chief difficulties, and discovered the two unknown quantities, neither of which could have been found separately: first, where the parasite appeared in the tissues of the mosquito, and second, the kind of mosquito in which the parasite was found.

Now on the eve of complete triumph, an exasperating delay occurred. Ross was removed to a station in which there was no malaria; but thanks to Manson, he was put on to special research duty. He had learned how to keep mosquitoes alive for longer than Manson thought they lived, and he soon followed the development of the parasite through all its stages in the mosquito—the growing zygote in the stomach wall of the insect, the development of the sporozoites in the zygotes, the bursting of the zygote outwards, the spread of these sporozoites through the body juices of the mosquito, the presence of the salivary glands in the fore part of the body of the mosquito, the gathering of the sporozoites into the glands, the duct leading from the salivary glands direct to the proboscis of the mosquito, and the final and conclusive proof, the infection of healthy birds by the bite of mosquitoes containing these sporozoites in their salivary glands. Can we wonder that when Manson announced these discoveries to the Tropical Section of the British Medical Association at Edinburgh in 1898 they created a "profound sensation among the members", who stood and cheered?

To estimate the advance made by these discoveries, it is worth while for a moment to turn to what men knew of malaria when Ross began his work. Laveran had discovered the parasite of malaria. Malaria was no longer a vague mist floating over a swamp, that entered a man and caused chills and fevers, with a rhythm almost like the changes of the tide or the phases of the moon. The miasmic hypothesis of malaria was a fine conception; it explained better than any other all the facts of European malaria. It was, indeed, a very brilliant explanation of one of Nature's most cunningly hidden secrets. In Europe, it was true that malaria was a disease of low-lying swampy places, and that elevation gave immunity from the disease. But unfortunately, the explanation that fitted European malaria totally failed to explain it in other parts of the world. There, malaria was often virulent when there was only fast-running water and not a swamp within miles. Some of the most intensely malarial places were among the hills. Malaria occurred in deserts, as well as jungles; or in towns which were neither jungles, deserts, nor swamps.

Laveran gave precision to the conception of the disease, but did not show how it spread from man to man, although he had suggested that it might be carried by the mosquito. There were speculations and observations and experiments in abundance. Air, earth, and water were searched. Every excretion of man was examined: and claims were made that we now know were false. King in 1883 suggested that the mosquito picked up malaria in a swamp and infected man when it bit him, and gave nineteen reasons for this supposition, some of which were attractive and true within limits. Smith and Kilborne showed conclusively that Texas fever of cattle was caused by *Piroplasma bigeminum*, a blood parasite with some resemblance to the malaria parasite, and that it spread by means of the tick; but they failed to discover the parasites in the tick, and still less to demonstrate an elaborate life-history like that of human malaria in the mosquito. Manson thought the mosquito received the disease from man; that it died on water, and that man became infected either by drinking infected water or inhaling infected dust. Manson failed to prove that mosquitoes transmitted disease, because, even for so large a parasite as the *filaria*, his method and technique were at fault: method and technique being to science what organisation is to business, and at times even more essential.

In the long and arduous search, Ross had nothing to help him but his own indomitable perseverance and the genius to recognise what he saw. Had he not persevered and won through, the secret might have been a secret still. What a difference that would have made. If Manson could say that in some measure his only claim was he had discovered Ross, in like measure it might be said that Ross discovered to the world the genius of Manson. I can imagine the Goulstonian lecturer of 1998 referring to Manson and Ross, tracing their researches and discoveries, and the subsequent discoveries of the transmission of yellow fever, trypanosomiasis, tick fever, typhus fever, and other diseases by insects, and then asking his audience to think what a happy chance brought these two great men together.

Ross was happy in his great discovery. He was pleased at the honours he received. They were the highest the academic and scientific world could give. But he was never unduly elated, and he never forgot and never ceased to say that his work was not done for the sake of science, but for the sake of his fellow-men.

It was a bitter disappointment that the world made so little of the knowledge he gave it. With his far-seeing mind he realised that by his discovery the work of prevention was not ended,

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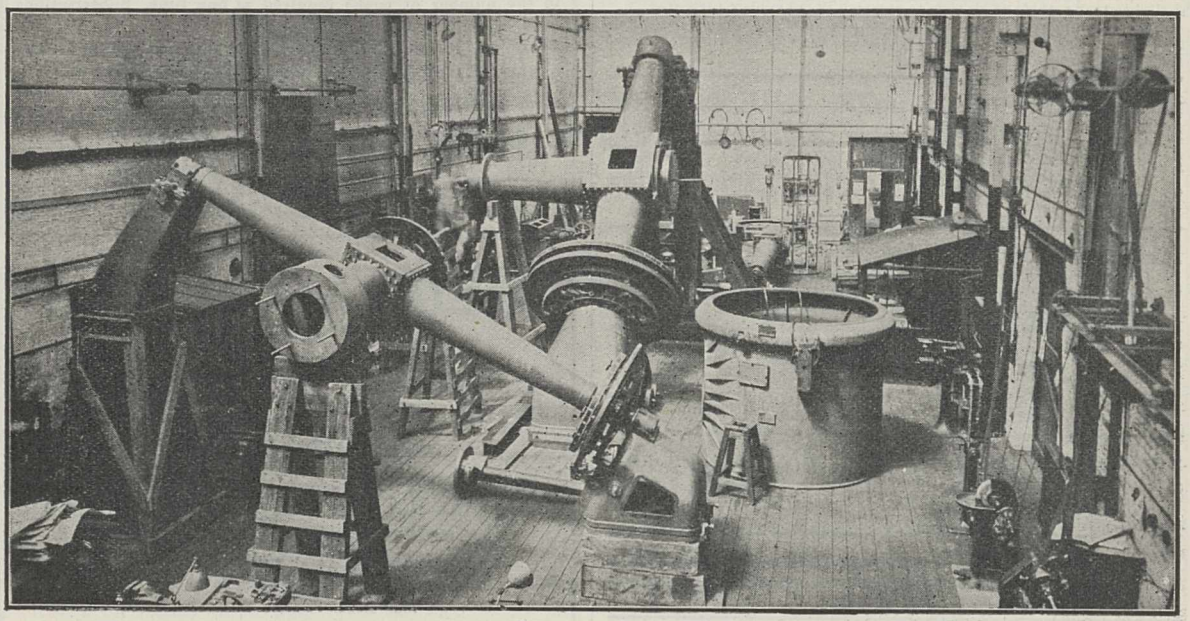

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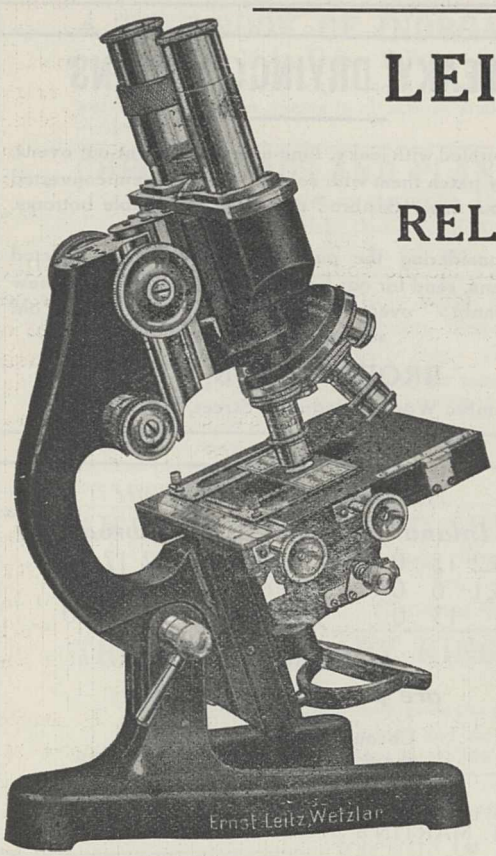

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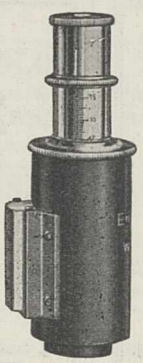

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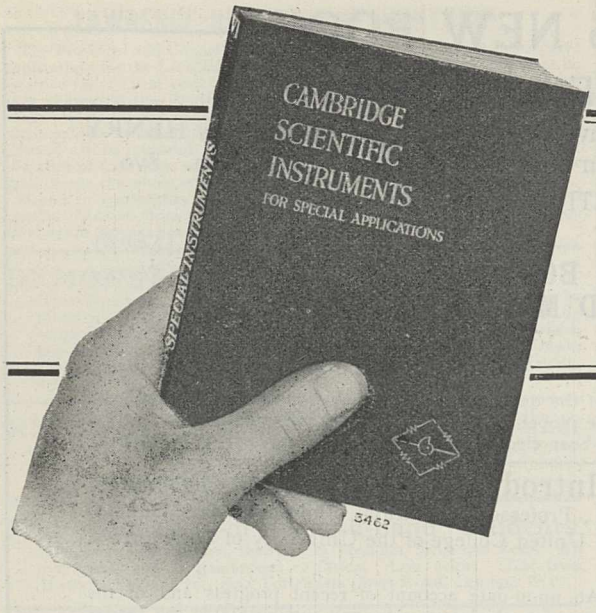

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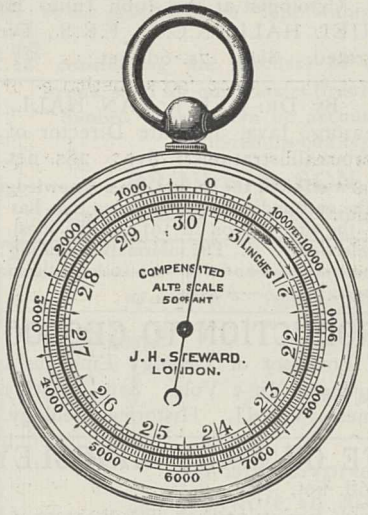

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but only begun. Even in the hour of triumph, when the shouts of victory might have distracted him, he wrote, in the very first paper he published after the discovery, that the way of progress was by further "experiment and research". It was, however, to be "experiment and research" on a scale larger, in time and space, than the medical profession had visualised, and the results have come in slowly for that reason; but solid progress has been made, and Ross's last birthday was brightened by good news from Africa about the development of the work to which he had devoted his genius and his life. Then clouds closed over one of the most active minds of his generation one of the foremost men of science of his time and on one of the great benefactors of mankind. He died at the Ross Institute, London, on Sept 16, 1932. MALCOLM WATSON.

News and Views

Sir Ronald Ross

FOR many weeks the thoughts of scientific colleagues everywhere, as well as those of a large group of the lay public, have frequently turned to the bedside of Sir Ronald Ross where he was lying grievously ill. All who knew Sir Ronald personally cherished the hope that they might again be privileged to meet him, though in their minds they knew that such an event was unlikely. The parting came on Friday last, when he crossed the dark river into the land of silence. To few men have such brilliant and intellectual attributes been given, and none has had greater influence upon the comfort and welfare of the human race. The versatility of his genius was really remarkable. Not only was he the author of several mathematical works of high order, but his volumes of verse showed him to possess rich talents of poetic conception and expression. His scientific work is appropriately surveyed on p. 465 of this issue by Sir Malcolm Watson, director of tropical hygiene and principal of the Department of Malaria Control at the Ross Institute and Hospital for Tropical Diseases, where Sir Ronald Ross died. We are fortunate in being able to publish this appreciation from one who did so much to apply the results of Sir Ronald's investigations to anti-malarial measures in the Federated Malay States, Singapore, and elsewhere, and has been closely associated with him at the Ross Institute for several years.

SIR RONALD ROSS was born on May 13, 1857, at Almora, India, and after being educated at a private school, studied medicine at St. Bartholomew's Hospital, and entered the Indian Medical Service in 1881. His investigations on the life-history of the malarial parasite and the means of preventing malarial infection began with a clue indicated by Sir Patrick Manson. When Ross first attacked the problem in 1895, at Secunderabad in India, the circumstances entailed much difficulty and many delays. Here he opened up an investigation as to whether the malaria parasite, discovered by Laveran, passes part of its life-history within the body of a living insect. After more than two years of fruitless experiments, Ross discovered a stage of the human malaria parasite in the tissues of the mosquito, anopheles, which had been allowed to feed on the blood of a malarial patient. In 1898 he proceeded to work out in detail the life-history of the malarial parasite found in sparrows and larks in India. He traced the stages in development of this parasite from its inception into the stomach of the gnat, *Culex fatigans*, which feeds on the blood of these birds, to its passage back into their blood through the secretion of the poison gland of the insect. Thus he furnished conclusive experimental proof of the part played by the insect in propagating the infection. Ross was elected a fellow of the Royal Society in 1901, and in 1909 was awarded a Royal medal of the Society. He was awarded the Nobel prize in Physiology and Medicine in 1902; and national recognition of his work is represented by the honour of K.C.B. conferred upon him in 1911 and K.C.M.G. in 1918.

Egypt Exploration Society's Jubilee

BY exhibiting two relatively small collections of objects and manuscripts from the many thousands presented to the British Museum by the Egypt Exploration Society during the fifty years of its existence, the authorities of the Museum have fittingly marked the jubilee of the Society and once more reminded the public of the way in which the national collections have been enriched and the sum of the nation's wealth increased by the benefaction of private effort. Yet the objects which may be exhibited in the collections of a museum, however intrinsically valuable, priceless for their rarity, or instructive as a means of re-creating the history or the everyday life of a vanished civilisation, represent but a part of the achievement of an association of private individuals engaged in the common pursuit of the scientific exploration of the obscurer phases of the early history of mankind. A year or two ago, when the Society for the Promotion of Hellenic Studies celebrated its jubilee, its services to the cause of classical scholarship and the study of early Mediterranean culture were duly recognised. The Egypt Exploration Society, having in view its wider appeal, may justly claim an even greater achievement. With no assistance from public funds, it has brought to light, restored, and handed over to the Egyptian Government in trust for future generations some of the most impressive of the monuments of Egypt's past, such as the temples of Deir el-Bahari, the Osireion, and the tombs of Beni Hassan, while its most recent excavations in a humbler, but historically no less instructive, sphere at Amarna have revealed the material surroundings and dwelling-places of the general population of an Egyptian city.

THE activities of the Society in excavation have afforded an opportunity to many well known in the archæological world for the exercise of their skill. The list would be too long to recite, but the names of Petrie, Naville, Hall, Hogarth, Hunt, Grenfell, and Woolley in this connexion immediately leap to the mind. Their work has been recorded in the scholarly and beautifully illustrated publications of the Society. In the collections now specially exhibited in the Egyptian Galleries and the Manuscript Saloon of the British Museum may be seen some of the choicer relics excavated by them. These have been given to the Museum, it should be added, as the agreed method of disposal of the finds allotted for the share of the expenditure raised by subscription from private individuals. Over two score manuscripts, which include the priceless "Sayings of Jesus", new poems by Sappho and Bacchylides, and the text of Pindar's "Pæans", are shown. Among the more striking archæological exhibits are the polychrome glass fish from Amarna and the sandstone sphinx inscribed with the famous pictographic script of Sinai, both of which have attracted much attention from the public, the diminutive gold statuette of Re, and the silver shrine from Daphnæ. With a number of exhibits of decorated glazed ware discovered at Amarna in the last two or three seasons' work is the unique Eighteenth Dynasty ivory *ushabti* from that site, whence also comes, among the finds of the season just past, the remarkably fine engraving of a young king's head on limestone, while the limestone head of a bald-headed old man, shown near by, comes from Deir el-Bahari. The relics from the recently discovered Buchæum, the temple of the Buchis bull cult, are here on exhibition for the first time. The larger objects and statues in the Gallery, for which the Museum is indebted to the Society, have been specially labelled.

Old and New Pharmacy

A WRITER in the Sunday *Observer* recently deplored the passing of the old-time English pharmacy with its window display of stoppered carboys of coloured water and its opal and gilded drug-jars. The loss of these emblems coincides with a change in the character of the pharmacist's occupation. The centralisation of manufacture tends more and more to convert him into a distributor of compounded medicines, in place of the skilled technician who made his own preparations out of crude drugs; but it must not be forgotten that he must now know a great deal more, about more complex drugs, than the old-time pharmacist. Side by side with this change there has grown up a demand on the part of pharmaceutical and fine chemical manufacturers for a new kind of pharmacist, whose knowledge is varied enough to enable him to deal with the new developments in therapeutics to which chemists, pharmacologists, and physiologists are constantly contributing. Much the same type of pharmacist is required by the great hospitals, which in these days often undertake the manufacture of pharmaceutical products on a considerable scale, for the use of their patients. To meet these new demands pharmaceutical education in Great Britain has been and is still being remodelled, and if any justification is needed for the changes the Pharmaceutical Society is making in this direction, it will be found in the new "British Pharmacopœia", to be published next month. The advance notices of this work, which have appeared in the technical press, indicate that it will make greatly increased demands on the knowledge and skill of the pharmacist, even where he is only concerned with the care and distribution of the vast number of products used in modern medicine.

British Pharmaceutical Conference

IN these circumstances it was peculiarly fitting that the chairmanship of the annual meeting of the British Pharmaceutical Conference at Aberdeen should have fallen this year to Mr. Herbert Skinner, the veteran pharmacist of the Great Northern Hospital and a former president of the Pharmaceutical Society of Great Britain. In his opening address, Mr. Skinner deplored the tendency, which exists even among medical men, to regard the hospital pharmacist as merely a dispenser of medicines, and out of his own rich experience drew an interesting picture of the duties and responsibilities attached to such a position, in the course of which he insisted on the necessity of maintaining a laboratory in every pharmacy, if the pharmacist is not to lapse into a mere distributor. The number of papers contributed to the Science Section of the Conference was twenty-nine, which is stated to be a record. It is perhaps to be expected in a year which sees the advent of a new "Pharmacopœia" that these papers should be largely concerned with methods of analysis of drugs. The importance of this kind of work is obvious, since upon it depends control of the purity and strength of drugs, but it is to be hoped that at future Conferences there will be more papers of the type contributed by Dr. Linnell and his colleagues on the synthesis of pressor substances and local anæsthetics, since these imply the development of interest in the synthesis of new drugs in Great Britain.

New Zealand Earthquake of Sept. 16

SINCE Feb. 3, 1931, the strongest earthquake in the Hawke's Bay district is that which occurred at 1·30 A.M. on Sept. 16. In 1931 the principal damage was confined to Napier, Hastings, Waipawa, and other places lying within an elongated area about fifty miles in length and directed north-north-east. The earthquake of Sept. 16, though much less intense and unaccompanied by loss of life, was strong enough to cause slight damage, such as the partial collapse of some houses at Wairoa and Gisborne, to the north of Hawke's Bay. These places lie nearly along the continuation of the areas mainly shaken in 1931, but the centres of the two meizoseismal areas are separated by about eighty miles. The point of chief interest about the recent earthquake is the continual migration of the focus in the north-north-easterly direction from 1855 until 1931 and again until Sept. 16 last.

Henry Cavendish

WITH reference to a paragraph which appeared in these columns in the issue of NATURE for Aug. 6 (p. 198),

in which the ascription of the title 'Honourable' to Henry Cavendish was described as a persistent delusion, Dr. E. J. Holmyard writes: "This stricture appears to be based upon a misapprehension. It is only within the last hundred years that the title 'Honourable' has been conventionally limited to the children of peers below the rank of marquis, and that it was commonly given to Cavendish is shown both by the admission register of Peterhouse (where he is described as 'Honorabilis Henricus Cavendish') and by the fact that Wilson's 'Life' (London, 1851), written when many of Cavendish's contemporaries were still living, employs the title without comment." Dr. Holmyard, however, will find that the definition of the term given in early reference books (for example, "Encyclopædia Britannica", 3rd ed., 1797) is exactly the same as the one in force to-day, and allows no excuse for the ascription to Cavendish. Cavendish's father, Lord Charles Cavendish, was not a peer, and however loosely the term might have been used and accepted in those days, it seems quite clear that Henry Cavendish had no right to it, and that it was incorrectly applied to his name and has been as incorrectly accepted without question until now.

League of Nations Intellectual Co-operation Organisation

THE International Institute of Intellectual Co-operation (2 Rue de Montpensier, Paris I) has just published the first number of a new monthly *Information Bulletin*, as the official organ of the League of Nations Intellectual Co-operation Organisation, which comprises a committee of the League with its secretariat at Geneva, the Institute in Paris, committees of experts, and national committees. It is a counterpart in English of the Institute's *Bulletin de la Coopération intellectuelle*, most of the contents of which will be summarised in it. This first number contains a review by the director of the Institute of recent developments in this field, special articles on the reorganisation of education in China and on "Moral Disarmament", a summary of the month, reports of meetings held under the auspices of the League's Organisation, and notices of forthcoming congresses. A foreword by Sir Eric Drummond commends it to the notice of all those who are interested in the promotion of international co-operation in art, education, science, and scholarship and believe that its progressive development is an essential condition for the gradual realisation of the principles for which the League of Nations stands. The annual subscription is 10 shillings or 2 dollars: single copies, 1 shilling or 20 cents.

Soil Physics in Relation to Meteorology

DR. B. A. KEEN, of the Rothamsted Experimental Station, discussed "Soil Physics in Relation to Meteorology" at the G. J. Symonds Memorial Lecture for 1932 of the Royal Meteorological Society (*Q. J. Roy. Met. Soc.*, July). This new branch of physics has made it necessary to discard a number of generally accepted explanations of agricultural and horticultural matters connected with the soil. Russian work on soil classification has, for example, led to the recognition of certain soil groups as a basis for a survey of the soils of the whole world, and it is found that the type of soil formed in any place is dependent not so much upon the geology of the neighbourhood as upon certain meteorological factors, especially temperature and rainfall. Analysis of vertical sections of the soil, or soil 'profiles', shows unmistakably that the amount of percolation of rain water decides whether certain alkaline salts derived from the weathering of rocks shall be washed downwards or not, and it is because of their effect upon percolation that these two meteorological factors are so important. As an offset to this case of underestimation of meteorological influence, Dr. Keen cites a case of overestimation, the subject being the aeration of the soil. The point that had to be explained was how it comes about that the composition of the soil atmosphere is so nearly the same as that of ordinary air, in spite of the fact that most biological activity in the soil tends to absorb oxygen and evolve carbon dioxide. A critical examination of the different processes leading to gaseous exchange between the soil and the atmosphere points to ordinary gaseous diffusion as the principal agent of exchange, meteorological processes being too slow. The rate of diffusion, moreover, is dependent upon total pore space rather than upon the size of individual pores, which would appear to dispose of the idea that 'heavy' soils—those with the smallest particles—are necessarily the most badly aerated. Another important point made in the lecture is that water is not conveyed to the surface of the ground by capillary action from nearly such great depths as had at one time been supposed, from which it follows that the good effect of a surface mulch of loose soil or other material is often unconnected with the reduction of evaporation from the surface.

The Newcomen Society

THE Newcomen Society for the study of the history of engineering and technology has just published its tenth volume of *Transactions*, containing the papers read during the year 1929–30, various notes and contributions, and a subject list of books and pamphlets relating to the history of technology, 1931–32. To mark the completion of ten years' labour, the Council has included in this volume a complete index to the whole of the *Transactions* and also an index to the various bibliographies. Both these indexes should prove of great use. As usual, the papers and notes cover a very wide field, ranging from ancient civilisations to the first steam engine in America and bell-founding; while the printing and illustrations leave little to be desired. The Society's financial position is sound, and the membership has increased slightly; more than a quarter of the members reside in the United States. Each year the Society holds a short summer meeting in the provinces, and it never fails in bringing to light the existence of historical industrial sites or directing attention to the industrial history of the district in which it meets. From time to time it has either taken the initiative or co-operated in the commemoration of the centenaries of

eminent engineers and inventors, and we understand it has already taken steps which should ensure the proper recognition of the centenary of the great Cornish engineer Richard Trevithick, who died in 1833. Trevithick died in poverty at Dartford and lies in an unknown grave, but in 1883, through the action of the Institution of Civil Engineers, a window in his memory was erected in Westminster Abbey. He was one of the most gifted inventors who ever lived, while as an engineer he was the pioneer of the high-pressure steam engine, and this at a time when the authority of Watt, who would have nothing to do with high pressures, was almost world-wide.

An Empire Museum Survey

AMONGST many topics dealt with by Sir Henry Miers in his fourth presidential address to the Museums Association was that of an Empire Museum Survey. A few years ago the possibility of so great a venture would have occurred to no one; now the Survey itself is far advanced towards accomplishment, thanks to the initiative and energy of Sir Henry Miers himself. It began with the Carnegie United Kingdom Trust survey of the museums of the British Isles; it was continued with rapidity when the Carnegie Corporation of New York, in addition to all it is doing for the United States, expressed its willingness to expend certain funds allocated for expenditure within the British Empire (exclusive of the British Isles) upon such a scheme. In 1931, Sir Henry Miers and Mr. Markham visited 121 museums and galleries in Canada; early this year they visited all the museums they could discover in the Union of South Africa and in Rhodesia, as well as many others encountered on the return journey by Khartoum, Cairo, and Port Said. This year also a survey of museums in British possessions in the Mediterranean Sea was carried out by Alderman Squire and Mr. Herdman. So that in a year, from June 1931 until June 1932, two-thirds of the Empire Survey has been completed; and now there remain only to be tackled the Commonwealth of Australia, Tasmania, New Zealand, the West Indies, and a few almost inaccessible places like the Falkland Islands.

Mississippi Floods

THE disastrous floods in the Mississippi basin in the spring of 1927 have led to various suggestions for preventing their recurrence. These are critically examined by M. O. Messerly in a paper entitled "Les Travaux de defénse du Mississippi" in *Matériaux pour l'etude des calamités*, No. 3, année 1931 (1932). Several of the proposals would probably lead to effective defence, but are not feasible on the score of cost. The construction of reservoirs on the tributary streams would be useful but very expensive. In industrial districts, however, such reservoirs would have a local use, in addition to their protective value. Setting back the embankments along the lower reaches, if done on a large enough scale, would help considerably, but is scarcely practicable. Dredging of the bed would be effective, but only if continuous and on a very large scale. Afforestation might help in checking the flow of rainfall to the rivers, but even vast schemes might afford only small relief. In any case, the effect would not be felt for a generation or more. The most practical measures seem to be the raising and strengthening of the embankments at certain places, the construction of new drainage channels parallel with the main stream, and the straightening of the river in places to facilitate the flow of water.

Duck Decoy Ponds in Europe

SCIENCE Service (Washington, D.C.) publishes a Berlin message concerning the slaughter of migratory ducks by decoy ponds in Europe. In Germany there are at present eleven decoys, with an average annual catch of 40,000 ducks; in Denmark two, with an average of 12,000; in Belgium four, average not stated. England is said to have twenty-one, capturing about 600 ducks; and Holland to have the greatest number of decoys, 145, having an average yearly catch of 300,000 ducks—a number until now suppressed in the interest of the Dutch canning industry, which has built up a profitable export trade upon the proceeds of the decoys. The finding of ringed birds shows that the ducks caught in Holland come largely from Scandinavia and Finland, and the fear is that the supply will eventually fail under this serious annual drainage. The open season lasts from July 27 until Feb. 14, or even March 13, and a shortening of this period would have a good effect, but it is said that the Dutch Government is unwilling to interfere with a profitable home industry. Nevertheless, an effort will be made, at the International Conference, to have the open season reduced to a period from Sept. 15 until Jan. 31.

Bibliography of Newcastle-upon-Tyne Local Records

As all interested in bibliographical matters no doubt know, Newcastle-upon-Tyne possesses an excellent public library, rich not only in the books generally found in such institutions, but also particularly in works of local interest. Having regard to the fact that Newcastle-upon-Tyne and the district of which it is the centre have taken such a prominent part in the invention and the development of technical methods and appliances of great industrial importance, it is obvious that these records of local doings necessarily appeal to a far wider public, and the librarian, Mr. Basil Anderton, has done well in publishing a "Catalogue of Local Records". The catalogue falls into two main divisions, namely, an author list and a subject list, together with certain appendixes which are perhaps of more strictly local interest. The subject list will probably be the one that will be more generally consulted, and it contains material of the greatest value, especially to the historian of matters of technological or sociological import. It need scarcely be said that in a coal-mining centre like Newcastle-upon-Tyne, maps of the coal mines and royalties of the surrounding district play an important part, and give information of the utmost value to students of the development of the coal-mining industry. The catalogue appears to be very well executed, is well printed and published, and will form a valuable and useful addition to British bibliography.

Progress of the Ordnance Survey

THE Report on the Progress of the Ordnance Survey for the year ending March 31, 1932, directs attention to the steadily increasing sale of small-scale maps, particularly the one-inch scale. This is no doubt due

to their increased use by walkers and cyclists. The fourth revision of the one-inch maps is making progress in the south of England, and Sheet 144 has been published in the new style. On the other hand, the revision of the six-inch sheets has fallen into arrears, which it is hoped will shortly be overtaken. Owing to lack of adequate staff, it has become necessary to restrict revision of the 1/2500 scale plans to those sheets which are found to be very considerably out of date owing to development of the ground. By this restriction it is hoped to overtake the more important arrears of work in areas of recent urban growth. Key maps of Great Britain attached to the Report show that in the greater part of Scotland and Wales and much of England the last revision of the 1/2500 and six-inch scales was more than twenty years ago.

Manufacture of Electric Railway Equipment

THE surburban services of the Danish State Railway around Copenhagen are to be converted to electric working on the high-pressure direct current system at 1500 volts. We learn from the *English Electric Journal* for July that the contract for 42 motor coaches and 21 trailer coaches has been awarded to the English Electric Company. There are now 'English Electric' equipments operating railways in seventeen different countries of the world. The Danish State Railway is the fifty-sixth railway to be electrified with the Company's material. The first high-voltage direct current electric railway operating in the world was the Bury-Holcombe Brook route of the Lancashire and Yorkshire Railway. In 1913, the English Electric Company developed the motors and control gear used on this line, which operated on 3600 volts. Few companies have had such world-wide experience in making electric railway equipment of all kinds.

Baltic Geographical Studies

THE report of the twenty-fourth meeting of German geographers held at Danzig on May 26–28, 1931, has been published as a volume (Verhandlungen und wissenschaftliche Abhandlungen des 24 Deutschen Geographentages, Breslau), which contains, in addition to the proceedings of the conference, a number of valuable papers. These cover a wide range of topics, but perhaps the most striking is a series on Baltic geography, including a paper by Prof. G. Braun on the oscillations of level of north-western Europe and the development of the Baltic from glacial times. A tabulated chronology of changes in the area makes an interesting study. Prof. B. Schulz writes on the waters of the Baltic, and Dr. W. Quade contributes a long study on the evolution of the port of Danzig in relation to the changes in the mouths of the Vistula. This paper is illustrated by a number of old charts.

The Imperial Economic Committee

THE twenty-sixth Report of the Imperial Economic Committee consists of a review of its constitution and work, and traces the development of its terms of reference. Suggested at the Imperial Economic Conference of 1923, the Committee was brought into being in 1925 with very restricted terms of reference that dealt only with the marketing of Empire food products in Great Britain. This led to the institution of the Empire Marketing Board in 1926, the year in which the Imperial Conference widened the work of the Committee to include the consideration of raw materials of manufacture as well as foodstuffs, and also industries and trades. The Conference of 1930 laid stress on the survey of mineral resources, and entrusted the Committee with the study of various aspects of Imperial co-operation. Its numerous reports on various products and materials are of considerable scientific value.

Announcements

THE opening meeting of the eighth session of the Electroplaters' and Depositors' Technical Society will be held on Sept. 28, at Lyons' Angel Café, Islington, N.1, when a discussion will be held on "The Possibilities of Standardising Electrodeposits".

THE Institute of Transport has made the following premium awards for the session 1931–32: Institute Triennial Gold Medal to Sir Lynden Macassey; Railway (Operating) Gold Medal to H. H. Mauldin; Railway (Engineering) Gold Medal to Sir Harold Hartley; Road Transport (Passenger) Gold Medal to Horace M. Wyatt; Water Transport (Canal) Gold Medal to A. J. Pearson; and Institute Graduate Silver Medal to J. M. Powell.

ORNITHOLOGISTS will be interested in Messrs. Wheldon and Wesley's new catalogue of ornithological works, which includes 2039 items. The collection is notable for the large number of important books it contains, and readers unfamiliar with the demand for such works may be surprised to learn that the seven volumes of Lilford's "Birds of the British Isles" are priced at £32, Dresser's "History of the Birds of Europe" at £48, Gould's "Birds of Europe" at £70, and his "Birds of Asia" at £175.

THE following scholarships have been awarded by the Institution of Electrical Engineers for 1932: Ferranti scholarship to C. D. J. Statham (University of Sheffield); Duddell scholarship to P. J. Rattue (Staveley Grammar School); Silvanus Thompson scholarship to W. E. Arnold (London Midland and Scottish Railway Co.); Swan memorial scholarship to G. N. Davison (Sunderland Technical College); David Hughes scholarship to R. G. Armstrong (University College, London); Salomons scholarship to J. S. Wright (King's College, London); War Thanksgiving education and research fund (No. 1) to G. J. Scoles (University College, London) and T. H. Walker (University of Sheffield); Thorrowgood scholarship to B. O. Banks (Metropolitan Railway).

MEMBERS of the staff of the Rothamsted Experimental Station are offering to give, during the forthcoming winter, a few lectures on the experimental work of the Station, to chambers of agriculture and horticulture, farmers' clubs, farm workers' associations, agricultural societies, etc. No fee will be charged for such lectures, but the association engaging the lecturer must defray his expenses. The subjects offered include manures, soil micro-organisms, agricultural botany, agricultural chemistry, soil physics, entomology, and mycology. Further particulars can be obtained from the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

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.*]

Polarisation of Wireless Echoes

WE were much interested in Mr. T. L. Eckersley's description [1] of a method of demonstrating the polarisation of wireless echoes, but surprised to find that some of the results he mentions appear both contradictory to the magneto-ionic theory and also to those obtained when other comparable methods of polarisation delineation are employed in the same connexion. Soon after Mr. Builder and one of us described the occurrence of regular echo-doublets and suggested that they were composed of the two oppositely polarised magneto-ionic components, various methods of demonstrating the correctness of this hypothesis were devised by members of the group of workers associated with the Radio Research Board. Some months ago Mr. R. A. Watson Watt and one of us, at the Radio Research Station, Slough, and Mr. E. L. C. White and the other, at the Cavendish Laboratory, Cambridge, independently and simultaneously developed apparatus for demonstrating the different polarisations of the echo-doublet components. The Cambridge apparatus is similar in principle to that of Mr. Eckersley, but is somewhat simpler to construct and to adjust.

In the apparatus used at Slough (and also at Radio Research Station, Tromsö) a radio-polarimeter is used in which the polarisation of the separate components is delineated on a cathode-ray screen. This method possesses the advantage that the complete polarisation specification, circular or elliptical, right-handed or left-handed, is shown by the oscillographic trace, and it is not necessary to assume, *a priori*, as with Mr. Eckersley's apparatus, that the components are circularly, and not elliptically, polarised. (A brief description of this apparatus, together with a statement that the echo-doublet components had been shown to be of opposite polarisation, appeared early in July last.[2])

With both these methods, and also with still another in use at King's College, London, it has been demonstrated that the components of a doublet echo are oppositely polarised in sense, the usual but not quite invariable result being that, when simple splitting is in evidence, the component of lesser delay is of right-handed sense and the component of greater delay left-handed. (We here use the same convention as Mr. Eckersley and view the polarisation looking in the direction of propagation of the waves.) Many observations on split echoes have been made using these methods at Cambridge, the Radio Research Station, Slough, and King's College, London, and a full account of them will, we hope, soon be published. The results obtained by the different methods are in close agreement, and also fit in with those of previous polarisation determinations made on longer wavelengths using the frequency-change method.

In connexion with the daytime absorption of the waves, we find ourselves in disagreement with Mr. Eckersley both as to the experimental results and as to the interpretation of the magneto-ionic theory. Experimentally we have found that, with wavelengths such as Mr. Eckersley mentions, while both components may be present, the left-handed one is more frequently that of greater intensity. The presence of both components is in agreement with the observations of Krüger and Plendl,[3] who found that at vertical incidence waves of 53 metres were returned from the ionosphere plane polarised with a rotating plane of polarisation. This would be the result of the presence of two circularly polarised components with a varying phase difference. Our deduction from the magneto-ionic theory is just the reverse of Mr. Eckersley's, for we find that the theory suggests that it is the right-handed component which suffers the greater absorption.

We cannot understand the contradiction between our results and those of Mr. Eckersley, and look forward to the publication of a full account of his theory and experiments so that we can trace exactly where the difference lies.

E. V. APPLETON.

King's College, London, W.C.2.

J. A. RATCLIFFE.

Cavendish Laboratory, Cambridge.
Sept. 14.

[1] NATURE, p. 398, Sept. 10, 1932.
[2] *Wireless World*, July 8, 1932; see also *The Wireless Engineer*, p. 513, Sept. 1932.
[3] *Z. Tech. Phys.*, **12**, p. 673; 1931.

Spectrum of Cosmic Radiation

COSMIC radiation forms a whole series of lines or bands in its spectrum, as can be established by measuring its absorption coefficient. The most penetrating of its constituents, having energy of about 3700 million volts, originates, according to Sir James Jeans, in the annihilation of an α-particle and its two neutralising electrons,[1] while the next softer constituent, of energy about 950 million volts, is formed by the annihilation of one proton and its neutralising electron. In both these cases, as generally accepted, one can scarcely suggest any other interpretation. The interpretation, however, of the softer constituents by the formation of helium and higher atoms from 'metastable clusters' consisting of protons and electrons, as suggested by Prof. R. A. Millikan,[2] has supplemented the first assumption of the origin of cosmic radiation:

$$\text{Proton} + \text{Electron} = h\nu,$$

made by Sir James Jeans, which seemed unable to give more than one line and did not indicate any logical or numerical connexion between the energy value of the proton-annihilation constituent and those of softer ones.

The object of this note is to point out a curious regularity which seems to occur in the energy values of the constituents of cosmic radiation. If we divide the annihilation quantum of the proton $h\nu \cong 950$ million volts by $n(n+1)$, where $n = 0,1,2,3,4, \ldots$ we get the values tabulated below (expressed in millions) together with those observed in cosmic radiation:

n . .	0	1	2	3	4	5	6	7
$h\nu$ calcul. .	950	475	160	80	48	32	22	17
$h\nu$ observed .	~950	~450	~180	~100	?	~30	(22·5)	~15

The observed values given under $n = 5$ and $n = 7$ are the limits of the 'soft band' as established by Prof. Millikan by measuring its penetrating power in comparison with that of γ-rays of thorium C'', the value 22·5 million volts being their average.

If this is not a pure accident—and one can scarcely believe it is—it must appear very surprising that an equation of the form

$$h\nu = \frac{h\nu_{\text{annih.}}}{n(n+1)}$$

succeeds so well in reproducing the spectrum of cosmic radiation in terms of the energy value of annihilation

of the proton-electron system. For, it is the very form deduced by Schrödinger for the quantum levels of the rotator with free axis.

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[1] J. Jeans, NATURE, **128**, 103, July 18, 1931.
[2] R. A. Millikan, NATURE, **128**, 709, Oct. 24, 1931.

Cystine and Wool Production

IN 1928 Marston and Brailsford Robertson emphasised the importance of cystine in the biology of the sheep.[1] They considered that since a typical fodder protein such as that of lucerne contains 0·93 per cent of cystine and the keratin of wool fibre contains 13·1 per cent, cystine might well be a limiting factor in the production of wool. Three assumptions were made by them, namely, that the cystine content of pasture lies within certain limits, that cystine cannot be synthesised in the animal body, and that the cystine of wool fibre is relatively constant.

As regards the first point, Evans [2] and Aitken [3] have shown that the cystine of pasture grass is of such a small order, about 0·01 per cent, by weight, of dry matter, that, as pointed out by Rimington and Bekker,[4] the amount of cystine present in the grass consumed by a sheep cannot be made to account for the amount of cystine present in the fleece. The argument of Rimington and Bekker depends upon the correctness of the figures of cystine analysis of grass, which, as pointed out by Marston,[5] is one of extreme difficulty and complexity, and it is probable that the figures must at present be accepted with caution.

The results of a recent experiment performed in collaboration between the Rowett Institute and the Wool Industries Research Association, Leeds, which are to be published fully at a later date, throw light on the matter at a new angle. During the course of the experiment, a group of twenty sheep received 503 lb. of digestible protein. The crude weight of the wool produced during the same period was 72 lb. Allowance has to be made for grease, impurities, and moisture content. Thus :

	lb.	lb.
Crude weight of wool . . .	..	72
Grease and impurities . . .	15·5	
Moisture content . . .	10·4	
		25·9
Estimated weight of clean dry wool ..		46·1

The weight of the clean dry wool, therefore, corresponds to 9·2 per cent of the weight of the digestible protein fed. Accepting the figure of 13 per cent as an approximate value for the cystine content of wool, the 46·1 lb. of clean dry wool would contain 6·0 lb. of cystine, corresponding to 1·19 per cent of the weight of digestible protein food. Making the generous allowance of 40 per cent of the ingested cystine retained as wool, the cystine content of the protein fed would correspond to the figure of 2·88 per cent given for blood albumin by Brailsford Robertson and Marston.[1] The proteins actually fed were those of turnips, oat straw, maize, bran, oats, and distiller's dried grains. Since the cystine content of such vegetable proteins is much lower than that of blood albumin, it is difficult to avoid the conclusion that some synthesis of cystine took place.

Finally, in a series of important papers, King, Barritt, and their colleagues at Leeds have shown quite conclusively that the cystine content of wool fibre is not constant, but that it fluctuates within fairly wide limits.

It follows that the evidence available in contradiction to the hypothesis of Marston and Brailsford Robertson suggests that the cystine content of pasture is so low that it cannot be conceived as being a possible limiting factor in wool production, that synthesis of cystine very possibly occurs in the sheep, and that the cystine content of wool fibre is not constant.

The experimental evidence cited by Marston in a recent communication [5] is unsatisfactory. An experiment by Lines is quoted in which casein was contrasted with yeast (containing 3·5 gm. cystine a day) as a source of nitrogen superimposed on a protein-deficient basal diet. The yeast gave very much better results, but the vitamin, mineral, and other factors present in yeast were apparently ignored, and were certainly not controlled.

In a field experiment in Central Queensland, blood meal (containing 2·7 per cent cystine) was fed *ad lib.* to ewes and lambs, the maximum intake of 6 oz. a head a week being reached under drought conditions. Unfortunately, the experiment was not controlled, since a cystine-poor concentrate of equal caloric value was not fed to the control group. It is therefore impossible to say how much, if any, of the beneficial effect was due to cystine or even to protein.

The bulk of the evidence is thus in favour of the synthesis of cystine within the sheep, and the question of the possible mode of synthesis arises. Rimington and Bekker suggest the decomposition of symbiotic intestinal bacteria as the source. On this hypothesis, sheep reared from birth on sterilised foodstuffs (suitably supplemented with vitamins) should grow little, if any, wool. It is therefore a hypothesis capable of critical test. The fact that wool growth is at its maximum before the lamb's rumen has fully developed is against this view.

It seems to us possible that cystine is formed during keratinisation, and that cystine synthesis is a function of the wool follicle itself. The amount of cystine produced in a fleece would then depend upon the number and activity of the wool follicles, and not upon the cystine content of the food or the bacterial population of the intestines. It appears to us that this hypothesis accords more closely with the great diversity of weight of fleece grown by different breeds under the same environmental conditions.

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Research Association, Leeds).

[1] Marston and Brailsford Robertson, *Bull.* 39, Commonwealth of Austral. Coun. Sci. and Ind. Res., 1928.
[2] Evans, *J. Agric. Sci.*, **21**, 806 ; 1931.
[3] Aitken, *Biochem. J.*, **24**, 250 ; 1930.
[4] Rimington and Bekker, NATURE, **129**, 687 ; 1932.
[5] Marston, *Austral. J. Exp. Biol. and Med. Sci.*, **9**, 235 ; 1932.

Diffraction of X-Rays by Liquid Metals

WHEN a beam of monochromatic X-rays is passed through a liquid, the intensity of scattered radiation does not, in general, fall off uniformly with scattering angle. One or more regions of maximum intensity are usually observed, and these may appear as bands or diffuse rings on a photographic plate placed to receive the rays. These facts are well known. Nevertheless, it is probably true to say that no completely satisfying explanation of such effects has yet been produced. One of the most attractive proposals has been put forward by G. W. Stewart in a series of recent papers.[1] Stewart suggests that temporary groupings of considerable numbers of atoms or molecules in the liquid would account for the observed

diffraction effects. This view is somewhat strengthened by the observation that the maxima for the liquid state are frequently in positions very similar to those of the strongest maxima for the solid material. It therefore appears that the units in the liquid are probably trying to group themselves according to their customary positions below the melting point.

The testing of any quantitative theory of the liquid state will probably be much simplified if results on simple substances are available. With this end in view, we have recently carried out X-ray diffraction experiments on several liquid metals. So far, liquid sodium, potassium, rubidium, and cæsium have been investigated, and work on lithium, lead, zinc, cadmium, bismuth, and other elements is proceeding. Sodium, potassium, rubidium, and cæsium are of the body-centred cubic type in the solid state, and the liquids, at temperatures not very far removed from the melting point, each diffract the X-rays in one main direction, so that a single narrow band is observed. Fig. 1, showing the ring for rubidium, gives

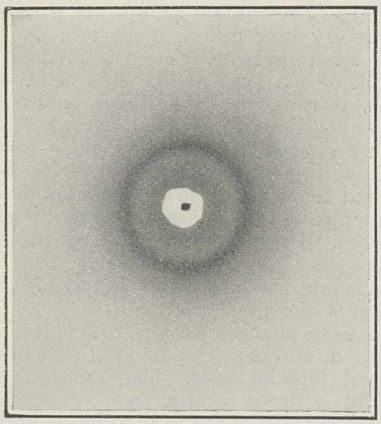

FIG. 1.—X-ray diffraction pattern for liquid rubidium. Copper $K\alpha$ radiation. Spacing of band, 4·09 A.

some idea of the rather surprising sharpness of definition obtained with all four liquids. The accompanying table gives approximate spacings of the bands. The metals were in each case distilled into exceedingly fine glass capillaries, and the melting carried out by means of an external heating coil.

Element.	Approximate Spacing in A. of Band due to Liquid.	Approximate Width of Band in Degrees at Half Intensity.	Spacing of (110) Plane for Solid in A.
Sodium .	3·01	6° 0′	3·04
Potassium	3·87	— *	3·68
Rubidium	4·09	4° 50′	3·97
Cæsium .	4·51	9° 30′	4·28

* Microphotometer records of our films for liquid potassium are not yet available.

It may be noted that in each case the spacing of the liquid band is approximately the same as the spacing of the strongest line of the corresponding solid. Work is now proceeding on the correct interpretation of these results, a full discussion of which we hope to publish elsewhere.

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Wembley, Aug. 19.

[1] See for example *Phys. Rev.*, **37**, 9; 1931.

Electrochemical Periodicities

DR. J. A. V. BUTLER and G. Armstrong[1] and Dr. E. S. Hedges[2] have published some very interesting observations on periodicities in electrolitic cells. I have made similar observations in a cell with 25 per cent sulphuric acid as electrolyte and a copper anode. The e.m.f. and resistance of the circuit being constant, under certain conditions the current through the cell assumes values from a few milliamperes to a fraction of a milliampere alternatively. The time of the alternations is variable, under different conditions, from about one to ten seconds.

This phenomenon lasts from several minutes to one hour or more, changing gradually. It is essential for the production of these oscillations that the ratio between e.m.f. and circuit resistance should have a certain value, corresponding to a critical value of the current density, approximately 43 ma./cm.[2]

This phenomenon is caused by periodical variations of the cell resistance,[3] due to the alternative formation and destruction of a thin insulating layer on the anode. This layer is analogous to that responsible for the passivity of metallic electrodes.

M. LIGNANA.

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University of Turin,
July 31.

[1] NATURE, **129**, 613, April 23, 1932.
[2] NATURE, **129**, 870, June 11, 1932.
[3] *L'elettricista*, Feb. 1932.

Thermochemistry and the Periodic Table

(ENERGY OF TRANSFER OF ELECTRONS ON OXIDATION)

SINCE the formation of chemical compounds depends on rearrangements among the electrons of the outer shells of the atoms concerned, it may well become the aim of thermochemists to connect changes of energy with the corresponding change in the arrangement of those electrons.

In my endeavours to develop the subject on these lines, I have been handicapped by scarcity of data. The energy of formation of the direct linking of oxygen to a number of elements has, however, now been obtained by C. R. Bailey[1] from the band spectra (in the infra-red) of a number of non-polar compounds examined by him at University College, London.

In the accompanying table these energies are correlated with the covalencies of the elements concerned:

Element.	Energy of Linkage with Oxygen (per gm.-atom of element). Kilo-cal.	Covalency of Element.	Column 2. / Column 3. Kilo-cal.
First Periodic Series			
Hydrogen . .	110	1	110
Second Periodic Series			
Carbon . . .	237	4	59·3
Nitrogen . .	171	3	57·0 — Mean 58·6
Oxygen . .	118	2	59·0 — Mean 58·6
Fluorine . .	59	1	59·0 — Mean 58·6
Third Periodic Series			
Silicon . . .	180 (?)	4	45·0 (?)
Phosphorus . .	148	3	49·3
Sulphur . .	101	2	50·5 — Mean 49·9
Chlorine . .	50	1	50·0 — Mean 49·9

In column 2 of the table, the energy of formation of the linkage H-O, as in water vapour, has been added to the series given graphically by Bailey.[1]

These energies of formation are seen to be a periodic function of the atomic number, being large for the early members of a series and decreasing steadily until

a minimum is reached for the last member of the series.

Such periodicity in a physical quantity is usual. What are not usual, however, are the regularities found in column 4. These call for special comment, and may be explained on the following lines :

(1) The covalency of the element is a measure of the number of electrons transferred from the oxygen in order to produce a stable shell.

(2) The energy of linkage divided by the covalency, therefore, represents that portion of the energy of the linkage which is directly associated with the transfer of one electron from the oxygen.

The energy per electron, estimated in this way, is seen in column 4 to have approximately the same value, 59 kcal., for the linkage of oxygen with each of the several atoms of the second series of the periodic table, that is, with atoms consisting of a nucleus and one shell of electrons. Lower values are obtained for linkages with atoms of the third series of the periodic table, that is, atoms consisting of a nucleus and two shells of electrons. The values approximate to 50 kcal. except in the case of silicon.

The value is 110 kcal. for the linkage with hydrogen, the sole member of the first series of the periodic table.

From these facts, it may be deduced that :

(1) The energy of formation of the linkage of an element with oxygen is proportional to the covalency of the atom of that element, depends on the number of electron shells in that atom, and is not affected directly by the nature of the nucleus ; (2) the ' energy of transfer ' of an electron on oxidation is approximately the same for all atoms with the same number of electron shells, and is smaller the greater the number of shells.

More data are needed before other linkages can be tested on these lines.

T. C. SUTTON.

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Aug. 22.

[1] C. R. Bailey, NATURE, **130**, 239, Aug. 13, 1932.

Observations on Filmed and Filtered Vowels

PROF. E. W. SCRIPTURE [1] has put forward a theory of the construction of vowel sounds, from which he concludes that " a vowel profile is a course of air vibration, muscular movement, nerve currents, and inner (psychic) activity ". In support of this he says : " [the vocal cavity] does not consist of a set of cavities connected by orifices but of one cavity of complicated form that cannot be analysed into separate cavities. . . . The shape of the vocal cavity is never constant for even the briefest instant ; it is constantly and continuously changing according to the muscular movements that regulate it." These suppositions require some amendment.

Until Sir Richard Paget made the first artificial vowel models in plasticine,[2] there was admittedly some doubt as to the action of the vocal cavity, but the experimental fact that a true vowel sound may be excited in a rigid cavity disposes of the view that the muscular flexibility of the mouth has any serious influence on the form of the complex sound produced. Nor is it true that the vocal cavity is a single one of complicated form. In all vowels two dominant inharmonic resonances can be detected,[3] arising from the division of the mouth by the tongue into two distinct cavities. In the ' front ' vowels (as in ' eat, it, hay, men, hat') it would appear that ' resonant ' vibration takes place in the larger rear cavity, and stationary vibration in the smaller front passage,[4] an arrangement similar to the modes of vibration of air in a flask with a long neck of narrow oval section. (This result was actually foreseen by Helmholtz.) The modes of vibration are then determined by the equation

$$\tan mh \,.\, \tan mk = \frac{a}{A},$$

when the ' neck ' is of length h and area a, and the rear cavity of length k and area A. In this instance, experiment has shown good agreement with this modification of the general theory of the double resonator.[5] The nature of the ' middle ' and ' back ' vowels is clear by experiment, but cannot at present be verified by theory owing to the great difficulty of bridging the gap between ' resonant ' and ' stationary ' vibration. The gap, of course, only exists in our range of mathematical tools.

The subject of compound resonance has been much confused in recent years by the use of mechanical and electrical analogies, many of which are misleading and some definitely at fault.[6] Branches of acoustics to which the electrical analogy has been successfully applied, such for example as the ' fingering ' of the flute, can usually be treated quite as easily, and always with more understanding, by the application of classical theory, and particularly by the use of those methods, now neglected, so beautifully presented by Lord Rayleigh.

Sir Richard Paget's work leads to the conclusion [7] that " the ear judges a vowel by the form of the compound wave. The ratio of the amplitudes is possibly quite as important as the ratio of frequencies, and a resonator is only successful in imitating a vowel when both ratios can be reproduced." This is in agreement with Prof. Scripture's hypothesis that " the vowel character depends on the general shape of the vibration profile ".

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[1] NATURE, **130**, p. 275 ; Aug. 20, 1932.
[2] *Proc. Roy. Soc.*, A, **102**, p. 752, *et seq.*
[3] Paget, " Human Speech ", Kegan Paul, 1930, p. 42.
[4] *Ibid.*, p. 292.
[5] *Ibid.*, p. 297.
[6] Compare Paget's " Human Speech ", pp. 285-288, with Dr. F. G. Richardson's " Sound ", pp. 55-57. Also *Proc. Roy. Soc.*, **101**, 391 ; 1922.
[7] Paget, " Human Speech ", p. 298.

Isotopes of Uranium

WE have succeeded in finding evidence of several isotopes of uranium which emit alpha-rays. In the expectation that the proportion of actino-uranium would be larger the younger the mineral, uranium from Colorado carnotite was used, the age of which has been variously estimated at from 170,000 to 7,000,000 years. The half-periods estimated by Wilkins [1] and by Rutherford [2] for actino-uranium, from quite different methods of reasoning, were 2·5 and 4·2 × 10^8 years respectively. The corresponding alpha-ray range would be about 3·2 cm.

In the present work, the alpha-rays from a very thin sputtered film of uranium fell at various angles on a special, fine-grained photographic emulsion 30μ thick, the grain distribution of which was shown to be independent of depth. The number of grains in the track of an alpha-ray in the emulsion was counted. A typical frequency curve for polonium is shown in Fig. 1, *A*, and for uranium in Fig. 1, *B*. The peak for the polonium rays is at 13 grains. The peaks in the uranium curve at 9 and 11 grains are taken as due to U I and U II. These three ranges agree with Laurence's values of the relative ranges of U I, U II, and Po. The analysis of the curve has not been completed but other alpha-rays of a subsidiary series with distribution peaks at 11, 13, and 16 grains seem indicated.

A peak at 11 grains might very well be due to actino-uranium. Those at 13 and 16 grains would indicate isotopes the ranges of which are remarkably close to proto- and radio-actinium.

The analysis of the curve is complicated not only by the fact that the relative abundance of the alpha-rays of the two series is unknown, but also that the shape of the frequency curve of a given member changes with the range. Data have, however, been

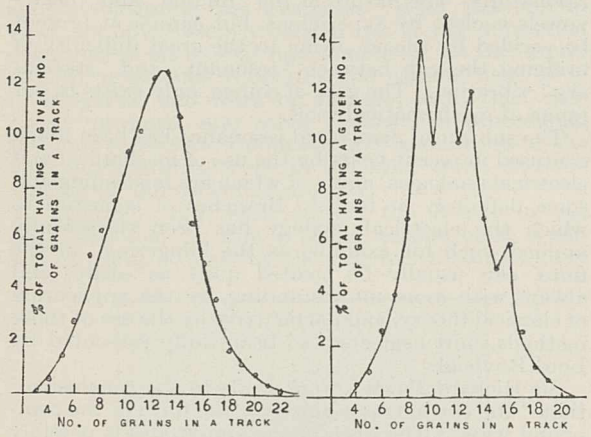

FIG. 1.—Typical alpha-ray frequency curves. *A*—Polonium. Polonium source above special laboratory lantern, emulsion 30μ thick. Data on 1038 tracks. *B*—Uranium. Sputtered uranium source above a special laboratory lantern, emulsion 30μ thick. Data on 2367 tracks. I—436, II—441, III—454, IV—544, V—492.

secured on this latter point. A study of the former using uranium from various geological horizons is expected to give an attractive method for determining the ages of rocks which appears to be free from errors inherent in the method based on U/Pb ratios. For the very recent uranium used in this work, the uranium and actinium isotopes seem to be about equally active.

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W. M. RAYTON.

University of Rochester,
Rochester, N.Y., July 3.

[1] NATURE, **117**, 719; 1926.
[2] NATURE, **123**, 313; 1929.

The Influence of Asia

JUST recently there has loomed in the mist of the past some wider conception of historical beginnings. By stating these we may awake attention to any further detail that may clear the view; the ideas may be modified when we come to close quarters.

A wide movement seems to take place periodically from the Caspian region to Syria and Egypt. Saladin the Kurd with his Turkoman troops conquered Syria and Egypt by A.D. 1170. About 950 B.C., models of box wagons and wheels, like those of Anau and Assyria, are found in Palestine, brought by Eastern migrants, who were probably the followers of Sheshenq (named from the Persian deity "He of Susa"), who conquered Egypt 940 B.C. By 2370 B.C. the Hyksos swept into Egypt, using the horse, and the toggle pin for dress fastening, usual in the Caspian region. At 3100 B.C. a skilful race of builders, using the toggle pin, and daggers with raised ribbing, both belonging to the Caspian basin, conquered Palestine and Egypt, as the Seventh Dynasty. An Asiatic movement about 5500 B.C. brought lazuli and the use of the face-veil into Egypt. Long before that, the names of the principal sites of the Caucasus were embedded in the Osiris mythology of the Egyptians, brought with emmer wheat from that region by the Badarians, who were certainly Asiatic. Each of these invasions helps our understanding of the others.

Another serial connexion begins with the celebrated ivory carving of Gebel el Araq (4800 B.C. ?), bearing figures of animals that are unsurpassed for truth and grace; it belongs certainly to Elamite art, and exhibits the conquest of Egypt by the dynastic race coming from the Persian Gulf. Three or four centuries later there was a school of fine ivory carving—as the old king from Abydos—and after a similar interval the finest minute portrait carving of Khufu in ivory. It seems impossible to suppose a race re-inventing such skill disconnectedly; it is an obvious series. That compels us to assign the highest Egyptian sculpture of the pyramid age to a Persian origin.

The group of a deity restraining lions, on the same ivory of Gebel el Araq, is the first known example of a long train of such emblematic groups, where a god or goddess subdues horses, bulls, swans, wolves, or snakes, as a symbol of power over Nature, a symbol which pervaded Persia, Mesopotamia, early Greece, and Italy. Again western Persia has been the starting point. All of this indicates the link of civilisation between the Indus and Tigris which has been demanded by recent discoveries. The dates stated above are those given by the Egyptians.

FLINDERS PETRIE.

Selection and Growth in Shore-Crabs

PROF. J. B. S. HALDANE in his new book entitled "The Causes of Evolution", p. 89, quotes the late Prof. Weldon as his authority for the statement that when the breakwater was built across the mouth of Plymouth Harbour, "the water inside became muddier, and the shore-crabs developed roomier gill-chambers". This is a complete mistake—in fact, a double mistake. Prof. Weldon did not assert that the branchial cavities of the shore-crabs had become larger, and what he did assert was shown by myself at the time to be incorrect. The subject is discussed in detail in my "Modern Biology" (1928), pp. 189-199.

The conclusion actually drawn by Prof. Weldon was that the increase of sediment in the water had, by selection, caused a decrease in the relative frontal breadth, which involved a better filtration of the water entering the branchial chambers. One point of my criticism was that efficiency of filtration could not be dependent upon a *relative* size of aperture, but must be proportional to the absolute size of aperture. The efficiency of a sieve is proportional to the size of the meshes, not to the total diameter of the sieve. Prof. Weldon's figures show that while the relative frontal breadth in thousandths of the carapace length was decreasing with increase in that length (that is, with the growth of the crab), and also in 1895 and 1898 as compared with 1893, the absolute frontal breadth increased in each year from 8 mm. to 11 mm. as the carapace length increased from 10 to 15 mm., and showed no decrease at all in one year as compared with another.

What Prof. Weldon actually investigated, therefore, was not a case of selection but a case of differential growth. The change of shape in the growing crab was known vaguely before; Prof. Weldon investigated it quantitatively in minute detail. But he did not show that the filtration of the water entering the branchial chambers depended on the relative frontal breadth, and he did not state that there was any relation between increased sediment and enlarged branchial chambers.

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Research Items

Indians of Matto Grosso, Brazil.—Ethnographical and archæological results of an expedition through Matto Grosso, Brazil, to the head waters of the Xingu River in 1931 are described by Mr. V. Petrullo in the *Museum Journal* (Philadelphia), vol. 23, pt. 2. A number of tribes were visited, of which one, the Tsuva, had not previously been recorded, while three, the Kalapalu, the Kuikutl, and the Naravute, had not been described. At the head waters of the Xingu, although three widely distributed linguistic stocks are represented and they are surrounded by a fourth, no appreciable difference of material culture is to be observed. The villages are composed of a few houses around a clearing. The men's house is of inferior construction, and although it is the men's meeting place, it is not used for sleeping. It serves for ceremonial uses and for the entertainment of guests only, while the men of the village sleep in their own family dwellings. Usually several families live in one dwelling; and a young man on marriage lives in the house of the bride's father until he is in a position to build a house for himself. Women are the authoritative persons of the village. Inheritance and descent proceed through them; and although the men deal with strangers, the women must be consulted and their concurrence obtained before any arrangement may be concluded. Marriage is monogamous, but only as a matter of practical and economic convenience. Headmen sometimes have two wives. Most of the groups cultivate nothing but manioc, though some have maize. The Yawalapiti keep maize effigies suspended from the rafters of their huts. These are made of an ear of maize embellished with legs, arms, a skirt, and a painted visage. Some images are in the form of birds. In one village a harpy eagle was kept in a conical structure, and every man had to share with it the proceeds of his hunting or fishing, receiving in return a feather when its plumage was ceremonially plucked.

Inherited Differences in Taste Reactions.—It has recently been shown that individuals differ in their capacity for tasting certain substances, and that these differences are inherited. The results of an experiment with phenyl-thio-carbamide, made at the New Orleans meeting of the American Association for Advancement of Science last December, are recently published by Dr. A. F. Blakeslee and Dr. A. L. Fox (*J. Heredity*, vol. 23, No. 3). Of 2550 persons tested, 65·5 per cent tasted the substance as bitter, 28 per cent found it tasteless, while 2·3 per cent found it sour, and 4·2 per cent reported another taste. Earlier tests of families had shown that the failure to taste it is inherited as a simple Mendelian recessive. When both parents are non-tasters, all the children are the same. This is found to be the case in 39 children from such parents. Individuals also differ in the threshold of stimulation, some being able to detect the taste in a few drops of a 1/500,000 solution, while some non-tasters require a hot saturated solution to perceive any taste at all. This substance, which is bitter to most people, differs from dalcin, which is three hundred times sweeter than sugar, in that an atom of oxygen is replaced by sulphur. The related *p*-ethoxy-phenyl-thio-carbamide is identical in taste, but apparently gives a slightly weaker reaction. Similarly fumar-proto-cetraric acid, a bitter constituent of certain lichens, distinguishing them from closely related species, is tasteless to some, while others find it bitter in varying degrees. The odours of certain verbenas and freesias are also found to produce various sense reactions in different individuals, some finding particular varieties odourless. By tests of this kind, inherited differences in our sense organs are coming to light (see also NATURE, **129**, 735, May 14, 1932).

Pig-feeding Experiments.—The first Pig-feeding Report of the Harper Adams Agricultural College summarises the experiments in pig-feeding carried out between 1926 and 1931. Briefly, these showed that a ration of cereal meals was deficient in proteins and certain minerals for the needs of a rapidly growing pig, but that extracted soya meal, supplemented by lime and salt, gave as good results as fish meal when added to a cereal ration. An average proportion of about eight per cent of soya meal was found to be adequate, this being best secured by using about twelve per cent in the ration for a newly weaned pig, and gradually reducing this to a minimum of 5 per cent at bacon weights. A mineral allowance of 1½ lb. limestone and ½ lb. salt per 100 lb. mixed meals was sufficient, and this seemed to be as effective as the more complex and expensive mixtures containing a great variety of minerals. For sty-fed pigs under normal conditions, about 3 lb. of water per 0·1 lb. meal were needed for young pigs, but this amount could be reduced to 1¾ lb. at bacon weights—a little more being allowed in hot weather. Many factors affect the economic value of milk in pig-feeding, and although whole milk gave a higher rate of gain than separated milk, yet the financial returns were lower than those obtainable by feeding separated milk, in conjunction with butter-making or cream-selling.

A Fresh-water Medusa from China.—T. Fujiwara (*J. Science*, Hiroshima Univ., Ser. B, Div. 1, vol. 1, 1932) collected, in August 1930, specimens of a fresh-water medusa from a pool about fifty miles south-south-west of Shanghai. They were all males and were present in large numbers, but the hydroid stage was not found. The author considers that the sex of the medusæ is not dependent, as has been suggested, on the temperature of the water but on that of the hydroid stocks. He reviews the records of fresh-water medusæ in eastern Asia and gives an account of the principal characters of his specimens, dealing in some detail with the statocyst, and he states that the ring-nerve is single. He does not actually state the species of his medusa, but remarks that it agrees in a good many points with *Craspedacusta sowerbyi*, var. *kawaii* (Oka, 1907), which he considers should be separated as a species *C. kawaii* from *C. sowerbyi*.

Chromosome Cycles and Sexuality in Sporozoa.—In a memoir (*Mém. Soc. de Phys. et d'Hist. Nat., Genève*, vol. 41, fasc. I. 1-223, 150 text-figures, 1931) on the Sporozoa with special reference to their chromosome cycles and their sexuality, André Naville gives an account of the present knowledge on the life-cycles and cytology of the Neosporidia and the Telosporidia. In a discussion on the fundamental distinctions between the Protista and the Metazoa, he expresses the view that this appears to consist in the absence in the Protista of autonomous somatic elements, but he points out that in the Myxosporidia and the Actinomyxidia there are non-generative cells which may be regarded as somatic. There are no corresponding cells in the Telosporidia, a difference which confirms the prevalent view that these two groups are distinct. In the last part of the work the author states his views, rather as a working hypothesis than as a real theory, on sexual polarity, not only in the Sporozoa but also in other animals and in plants. As an example of this polarity in the Sporozoa may be

cited the Adeleida, in which the polarised gametoblast produces a number of gametocytes at each of its two extremities—one group male and the other female. In the Metazoa, among the examples considered are *Hydra*, *Ctenophora*, and *Sagitta*. The author adds a glossary of special terms and three synoptic tables in which the life-cycles and the conditions as to haploidy and diploidy, so far as they are known, are summarised for the Neosporidia, the Gregarinida, and the Coccidiomorpha respectively.

Tetraploid Tomato Plants.—Tetraploid plants of the common tomato, *Lycopersicum esculentum*, have been produced by several workers by decapitating the stem of a diploid. Some of the shoots which grow out from the callus are found to be tetraploid. Such plants show a variable amount of association of their chromosomes in fours and a certain amount of sterility. This was greatest in a tetraploid produced from a doubled haploid, and its fruits were smaller than in the diploid. Prof. E. W. Lindstrom, continuing this method (*J. Heredity*, vol. 23, No. 3), has recently produced a tetraploid from the currant type tomato, *L. pimpinellifolium*. This species and *L. esculentum* have the same chromosome number ($n = 12$) and cross readily, although the hybrids show gametic sterility in F_1 and F_2. The tetraploid from *L. pimpinellifolium* is not only larger than the diploid in all parts, such as seeds, cotyledons, leaves, and fruits, but also it is highly self-fertile, although completely sterile in crosses with the diploid of either species. From it have been derived 248 mature plants in four generations. These segregated for red *v.* yellow fruits in the ratio 20 : 1, which suggests that random assortment of the eight chromotids may be taking place in meiosis. The origin of the yellow factor is uncertain, but may possibly have been from *esculentum*, as three later tetraploids of *L. pimpinellifolium* had somewhat smaller fruits than the first.

Oscillation of the Earth's Atmosphere.—In a recent memoir of the Royal Meteorological Society (No. 35, vol. 4), G. I. Taylor examines a suggestion that has been made to explain a discrepancy observed between the velocity of a free gravity wave in the earth's atmosphere given by tidal theory, namely 910 feet per second, and the values found by direct calculation and by observations of the air wave caused by the Krakatoa volcanic eruption or explosion of 1883, which come to about 1050 feet per second. The suggestion is that the discrepancy might be explained by supposing that rapid pressure changes take place adiabatically while those like the semi-diurnal pressure wave of the atmosphere are more nearly isothermal; it has been put forward by Prof. Taylor and by three other writers—Chapman, Pramanik, and Topping—who have discussed the theory of the oscillations of the earth's atmosphere in relation to observational evidence. Taylor shows that the above mentioned supposition is untenable because the transference of heat by radiation and conduction required to introduce an important difference in the speed of the wave from that consistent with adiabatic pressure changes must lead to so much damping that the amplification by resonance, required to give the observed semi-diurnal variation, even if the free period of oscillation were taken to be 12 hours instead of the customary period of 11 hours 56 minutes, becomes impossible. He finds, further, that the required resonance can only be arrived at if the time taken for an inequality of temperature to be reduced in the ratio e to 1 is greater than 76 hours. The upshot of this investigation is that the cause of the discrepancy between the theoretical value of the free period and the value 12 hours remains at the moment unidentified.

Composite Dyke of Breven, Sweden.—A detailed and stimulating investigation of the great Breven dyke has been published by T. Krokström (*Bull. Geol. Inst., Upsala*, 1932, pp. 243-330). The dyke has a length of 30 km., and ranges in width from 0·3 km. to 1·2 km. It is concluded from the results of geological, petrological, and chemical work that the exposures of the Breven dyke now visible represent a section of intermediate depth through a fissure that originally served as a channel for a series of extrusions all belonging to the same volcanic cycle. The material brought up by the successive eruptions probably emanated from a common magma reservoir, the different types of magma being along the normal line of differentiation within the reservoir (possibly accompanied by assimilation of the granite roof or walls). In chronological order the magmas corresponded to (*a*) olivine-dolerite; (*b*) olivine-free dolerite; (*c*) granophyre; (*d*) olivine-dolerite. During its ascent the granophyre altered the dolerite (*b*) by pneumatolytic action into an amphibole-rich, biotite-bearing intermediate type for which the name epidolerite is suggested. The latest olivine-dolerite is a restricted extrusion which took place after an epoch of denudation that uncovered the more deep-seated types of the dyke.

Intensities of Nebular Lines.—Bowen's conclusion that the characteristic spectra of nebulæ and certain novæ arise from improbable, but not completely forbidden, transitions in some light atoms and ions receives additional confirmation and some amplification from a theoretical investigation of the transitions by A. F. Stevenson (*Proc. Roy. Soc.*, August), in which their probability is calculated by approximate quantum-mechanical methods. This is of particular interest as leading to an estimate of the density of the gas in the nebulæ, on the assumption that it must be sufficiently small to make the time between the collisions of atoms or ions at least the mean theoretical time for the lives of the initial atomic states involved in the radiation. The numbers so obtained seem reasonable, the required time being at least about twenty-six seconds in regions where the so-called nebulium lines are emitted, and at least about three minutes where the red lines λ6583·6 and λ6548·1 originate, but it has to be remembered that one important 'forbidden' line, the celebrated λ5577 of the aurora, can be readily produced in the laboratory at pressures of the comparatively high order of a thousandth of an atmosphere.

Diurnal Variations in Cosmic Radiation.—Prof. A. H. Compton and a number of collaborators have given an account in the second July number of the *Physical Review* of the results obtained in measurements made on cosmic rays hourly for ten consecutive days, at an altitude of 3900 metres. The rays were recorded by the ionisation produced in a steel sphere of 10 cm. internal diameter, filled with air at 30 atmospheres pressure. The measurements were made relative to the effect of a radium source, a procedure which automatically eliminated a number of errors, and were finally averaged over the ten days and corrected for some pressure and temperature effects. It then appeared that the ionisation was $1{\cdot}5 \pm 0{\cdot}25$ per cent more between 8 A.M. and 4 P.M. than between 8 P.M. and 4 A.M., a result considered in satisfactory agreement with the results of other observers, if the variation is due to a soft component of the rays. It is suggested as a consequence that the inference previously made by Millikan and Cameron that the energy in the universe in the form of cosmic rays is comparable with that in the form of light is of doubtful validity.

Velocity of Light in a Magnetic Field.—It has been established with considerable accuracy by C. C. Farr and C. J. Banwell (*Proc. Roy. Soc.*, August) that the velocity of light in a vacuum of approximately one hundredth of a millimetre of mercury is unaffected by a transverse magnetic field. The optical system employed was a Jamin interferometer, in which the light paths were in fields of different strengths, one very small and the other of the order of 20,000 gauss. The whole apparatus was set up so as to minimise spurious shifts of the fringes, the position of which was watched by a number of observers as the field was established and switched off. The sensitivity of the apparatus was such that a relative change in speed of 1 part in 2×10^7 could have been apparent. By working with polarised light it was further shown that it was immaterial whether the direction of vibration lay in or at right angles to the applied magnetic field.

Diamagnetism of Bismuth.—Bismuth, which has always been of interest from its generally anomalous physical properties, has been the subject of much study recently in the form of single crystals. Goetz has confirmed in this way very strikingly the presence of an intermediate structure between the atomic lattice and the macroscopic crystals, giving for the average size of the discontinuities with which it is associated a few thousandths of a millimetre. In the April number of the *Indian Journal of Physics* it is pointed out by S. M. Rao that the existence of these sub-units of structure is in accord with the magnetic properties of the substance. Bismuth is diamagnetic, but the susceptibility depends upon the size of the particles used. Colloidal bismuth, when melted and recrystallised, shows an increase of up to thirty per cent in susceptibility, the change persisting even when allowance is made for contamination with oxide. The change of susceptibility with particle diameter is small for particles greater than about 1μ in diameter, but below this size falls off rapidly to the lower values, and for the smallest particles considered is still decreasing. The change in susceptibility thus occurs from about the particle size associated from other experiments with the mosaic structure, and affords confirmatory evidence for the reality of this.

Astronomical Topics

The Lunar Eclipse of Sept. 14.—This was the first lunar eclipse of considerable size that was observable in London under clear skies for a good many years. Lunar eclipses are of interest from the fact that they give a good idea of the general state of the earth's atmosphere, or at least of the portions of it over the regions where the moon is on the horizon. The amount of illumination within the shadow varies to a notable extent. In 1884 the moon could be seen only with great difficulty, while in 1895 the maria and other surface markings could be observed with ease. The late eclipse did not attain either of these extremes, but was perhaps somewhat darker than the average eclipse. The limb was discernible in the telescope without difficulty at all the stages of the eclipse, also the crater Aristarchus, which is the brightest point of the disc. The outlines of the maria, however, were not easily seen until the maximum phase was nearly reached ; this is an effect of the darkening sky ; when there is bright sky light over the eclipsed region, contrasts are more difficult to detect.

The part of the disc that was nearest the centre of the shadow was coppery in tint, but the parts nearer the edge of the shadow tended rather to bluish grey. There was a specially bright region at the north-east limb of the moon. As the moon traversed the northern portion of the earth's shadow, there was not much opportunity to test whether the air in the southern hemisphere was rendered opaque by dust from the recent eruptions in the Andes. The southern region of the moon was carefully watched ; it did not appear that there was any greater darkening there than that to be expected from deeper immersion in the shadow. The next total eclipse at which the moon will be high, in Great Britain, is on Nov. 7, 1938.

Capture of Comets by Planets.—The theory that all the comets of short period have had their orbits changed from parabolas to ellipses by near approaches to the great planets has been subjected to adverse criticism lately ; in particular, Mr. S. Vsessviatsky, in the *Observatory* for May last, indicated many points in which the theory gave results that did not accord with observed facts. M. Jean Bosler contributed another paper on the subject to the *Journal des Observateurs* for January last. It examines what proportion of the comets that make close approaches to Jupiter would have their orbits transformed into ellipses and hyperbolas respectively. He finds that the ratio between the two is nearly one of equality, but with a slight preponderance for hyperbolas. This is clearly a further argument, though not a very strong one, against the theory ; for it had already been shown that even if all the close approaches had led to elliptical orbits, there would not be enough to maintain the supply of short-period comets ; reduction of the number of ellipses by more than half would render the insufficiency still more marked.

It is not, of course, denied that such approaches may at times take place ; but merely that they are insufficient to explain the large family of short-period comets. In fact, a case seems to have taken place recently ; Ryves's comet, that was under observation a year ago, was shown to have approached Jupiter within a few million miles about a year earlier. A definitive orbit of Ryves's comet has not yet been computed ; but those that are to hand make it somewhat probable that the orbit, after passing Jupiter, was hyperbolic.

A New Stellar Photometer.—Dr. W. H. Steavenson describes, in *Monthly Notices, R.A.S.*, for June, a simple form of photometer which has lately been inserted in his reflector. A plate of glass about a tenth of an inch thick is placed in the focal plane. Some small dents in its surface were made with a diamond, and illuminated by an electric bulb placed at the side of the tube, in the plane of the glass. The remaining light of the bulb is totally reflected in the plate, and does not reach the eye. The illuminated dents have a stellar appearance ; their brightness can be adjusted by a rheostat to approximate equality with the star to be measured ; the remaining difference is measured by a sliding wedge. The wedge projects beyond the eyepiece ; its position for equality of light is recorded by marking on a card the distance of the end of the wedge from the tube, so that no artificial light is needed during the comparison. Ultimately the artificial star is compared with a known star in the north polar sequence. The different dents in the glass plate appear of different brightness, so that one can be selected near the magnitude of the object to be measured. Dr. Steavenson's extensive work on old novæ, etc., is well known. The new photometer should render the comparisons still more accurate.

The Value of Tuberculin Tests*

THE name 'tuberculin' has been applied to any extract, suspension, or other preparation of *B. tuberculosis* or of media on which it has grown. The Therapeutic Substances Regulations 1931 (Statutory Rules and Orders, No. 633) define the term in a more limited sense as preparations of fluid media on which the organism has been grown in artificial culture, which have been freed by filtration from the bacilli. When the filtrate has been concentrated it is known as 'old tuberculin'; its potency is measured by comparison with that of the standard preparation.

Although tuberculin is now scheduled under the Therapeutic Substances Regulations, the hopes originally raised that it would prove of value as a curative and diagnostic agent in tuberculous disease in man have not been completely satisfied. The diagnostic aspect of the problem has recently been investigated by P. D'Arcy Hart, who concludes that tuberculin tests are of definite value in certain circumstances, provided that the correct technique is observed. The Report is based on the examination of 1030 clinically tuberculous patients of all ages and types of infection, and 751 clinically non-tuberculous patients of all ages.

The intracutaneous or Mantoux test is recommended, since it is more sensitive than the cutaneous or von Pirquet test. The initial dose is 0·1 c.c. of a 1 in 10,000 dilution (in 0·5 per cent phenol-saline) injected into the skin of the forearm or upper arm. The result should be read at 48 hr. and 96 hr. A positive reaction consists of an area of erythema or erythematous infiltration the greatest diameter of which equals or exceeds 5 mm., or which is definitely greater than the reaction given by a control injection of the medium from which the tuberculin was prepared. If the test is negative, a retest should be carried out with a 1 in 1000 dilution; if this gives a negative response, a 1 in 100 dilution should be tried. A 1 in 10 dilution may be finally employed in confirmation. A positive reaction indicates hypersensitiveness of the tissues to a product, probably protein in nature, of the tubercle bacillus, and is probably only seen after tuberculous infection accompanied by the formation of histological tubercles has taken place. There is a significant interval between primary infection and the appearance of tuberculin skin reactivity. A positive response indicates merely that infection has occurred at some time in the individual's life, and not, on present evidence, that it is still active.

The positive reaction has its chief clinical value in infancy, when tuberculous infection is more likely than at other ages to be associated with, or to progress into, active tuberculous disease. The prognosis is worse the younger the patient and the more unfavourable the home conditions. An infant of less than two years, but without symptoms, should be kept under observation for several years. If obscure and persistent symptoms are present, the possibility of tuberculous infection as cause should be seriously considered. Between two and five years a positive reaction with persistent symptoms should suggest that the latter are tuberculous in origin: at more than five years of age this is much less likely to be the case. Quantitative tests, however, are of very doubtful value for estimating the prognosis in clinical tuberculosis.

A negative tuberculin reaction almost excludes the presence of tuberculous infection: with the 1 in 1000 dilution the average error in the author's series of cases was less than four per cent. With the 1 in 10 dilution, a negative reaction excludes clinical tuberculosis with an average error of a little more than two per cent (4 per cent in children up to five years of age, and 3·5 per cent in advanced cases of tuberculosis with marked toxæmia). The error is considerably greater with the 1 in 10,000 dilution, being 12 per cent. The usefulness of the test for the negative diagnosis of clinical tuberculosis depends also upon the chance of the patient giving a negative reaction should his condition, suspected of being tuberculous, be in reality due to some other cause. This chance is determined by the percentage of negative reactors among clinically non-tuberculous individuals of the same age and social status, and living in a similar environment. In Great Britain, the test can only be profitably applied for negative diagnosis, in patients of the hospital class in large cities, in childhood: in country and private practice it may also be of value in adults. The incidence of positive reactions in adults of the poorer classes in towns is too high to make a negative response of value.

Children from tuberculous households give a much larger percentage of positive reactions than those whose homes are free from this disease, and the percentage is greater when the tuberculosis is active or open than when it is closed or healed. Again, the incidence of positive reactions among children is greater when they live in contact with a tuberculous relative than when a tuberculous relative visits them only occasionally. The presence in the household of a sufferer from non-pulmonary tuberculosis does not increase the incidence of positive tuberculin reactions among the children. Infants separated from their tuberculous parents before infection has occurred and placed in healthy families appear to be no more liable to acquire infection in early life than the infants of non-tuberculous parents. All these facts suggest that the children of tuberculous families are more likely to acquire the disease than those from the non-tuberculous simply because they are more exposed to infection; in other words, no evidence of a hereditary predisposition to infection has been found by the author. Such a view is, however, not inconsistent with a conception of heredity as a determinant of the subsequent course of infection once this has taken place.

The practical conclusion from these results is that children should be kept out of contact with cases of pulmonary tuberculosis during the early years of their life, or that the chances of infection should be minimised by the careful hygienic control of the patient, such as that developed at the Papworth Settlement by Varrier-Jones. When it is considered advisable to separate the children, tuberculin tests will have an important rôle in determining which are the most suitable for this procedure.

The incidence of positive tuberculin reactions in a healthy community is an index of the risk of exposure which is determined by the frequency of open tuberculosis, the measures taken to combat it, the general hygienic standard of the population, and the infectivity of the milk supply. Unless tuberculosis can be stamped out and the population kept free from it, the development of a positive reaction in an otherwise healthy person is a favourable sign, since it indicates a degree of protection against the development of clinical tuberculosis. Natural tuberculous infection has a greater fatality in infancy than at other ages, so that it is advisable to postpone the first infection, if possible, to middle or later childhood, for example, by removal from contagion at home and by pasteurisation

* Medical Research Council. Special Report Series, No. 164: The Value of Tuberculin Tests in Man; with Special Reference to the Intracutaneous Test. By P. D'Arcy Hart. (London: H.M. Stationery Office, 1932.) 2*s.* net.

of the milk supply. It is, however, advantageous for the first infection to take place before adult life is reached, because of the partial immunity which may result. The evidence obtained from tuberculin tests in London school children suggests in fact that tuberculisation occurs chiefly in later childhood and adolescence, that is, when the principal activities of the individual are away from home.

It is hoped that further work will result in an answer to the question as to whether tuberculin sensitisation is decreasing in the population, following the improvement in general hygiene and control of tuberculosis. It is also to be hoped that an altogether satisfactory method of prophylactic immunisation will have been developed before the incidence of infection has fallen so much that the general population finds itself in the precarious unprotected state of a non-tuberculised race.

Winds and Weather on the Coasts of India

MR. S. BASU, of the Marine Section of the India Meteorological Department, Poona, has prepared a useful handbook on the winds and weather off the Indian coasts.* It is based, presumably, largely upon the logs of steamers of the merchant service voyaging in Indian waters, as well as on the work of meteorologists—notably Sir John Eliot—who have made a special study of the cyclones of this region, and is intended to be of service to Indian seamen. Assuming that the standard of accuracy to be expected of a professional meteorologist with extensive sources of trustworthy information has been maintained, this book should fulfil admirably the purpose for which it was written.

The most dangerous weather phenomenon with which the Indian seaman has to concern himself is of course the tropical cyclone. Tropical cyclones do not exhibit quite the infinite diversity of character shown by the cyclonic depressions of the North Atlantic, for they are definite vortices conforming to a fairly definite type. It is possible, therefore, to frame certain general principles that should be followed by a seaman who wishes to avoid exposing the vessel in his charge to the full fury of the inner circle of winds that so often attain to the full force of a hurricane. A special chapter is devoted to this problem, and contains hints as to how the exchange of weather information by radio between ships, together with the utilisation of the official weather reports issued by radio, can help in the navigational problem that arises when a ship approaches sufficiently near to a cyclone.

Another source of danger is the 'Nor'wester', a thunder-squall of early summer that is believed to have given rise to winds of more than a hundred miles an hour. It is primarily a land phenomenon, but is felt sufficiently far out to sea—70-80 miles out, according to the account of it given in the second chapter of the work—to be a menace in the Bay of Bengal.

In addition to information about the more violent weather phenomena, there is much useful matter relating to ordinary local winds and currents and their seasonal variations, and to tides. The last chapter describes the system of visual storm warnings in force throughout Indian waters.

The handbook is well arranged; the standard of printing is adequate, while the maps are clear in spite of their small size. It is not easy for a reviewer in Great Britain to accept the Director-General of Observatories' request for practical suggestions for increasing the usefulness of future editions—unless of course it is proposed to increase its length, in which case much additional information about local peculiarities in the weather could doubtless be included.

E. V. N.

* India Meteorological Department. Winds, Weather and Currents on the Coasts of India and the Laws of Storms. Pp. iii+51 and 18 plates. (Calcutta: Gov. of India Central Pub. Branch, 1931.) 2.6 *Rs.*; 4*s.* 6*d.*

Electric Discharge in Gas at Low Pressure

DR. I. LANGMUIR presented an interesting review of the electrical properties of the discharge in gas at low pressure, at the recent International Electrical Congress held at Paris. The advances made in this field in the last nine years, which have completely revolutionised our outlook, have come largely from his laboratory and from that of Prof. K. T. Compton.

In his recent paper, Dr. Langmuir confined himself to a statement of the more important mathematical relations which have been developed to give a starting point, somewhat simplified still in comparison with reality, for the investigation of discharges. In these there are two fundamental conceptions, that of a 'sheath' and that of a 'plasma'. Sheaths are found in general on the surfaces of electrodes or on the walls of the tubes, and are essentially regions in which there is a strong separation of charges of one sign. In practice these are usually positive, but by control of the potential of the solid boundary, they may be made of the opposite sign. The potential within them is governed by the well-known Poisson equation for the divergence of the electric intensity, and the currents across them determined chiefly by the rate at which particles from the main discharge diffuse to their boundaries.

The plasma is, on the contrary, a region in which the concentrations of electrons and positive ions are almost equal and opposite, and usually both large, of the order of 10^8 to 10^{13} per c.c. It has thus a high conductivity, in distinction to the sheaths, and almost invariably in the discharges studied by Dr. Langmuir, has exhibited the peculiarity that the distribution of velocities amongst the electrons in it has been Maxwellian, with a temperature between 5000° and 100,000°. The determination of these temperatures, and the simultaneous analysis of other features of the plasma, is perhaps the most valuable contribution to a more general theory of discharges from this work, and can be accomplished by taking the current-voltage characteristic curves for an exploring electrode. At the present time, the chief advances are being made as a result of the departures which have been observed from Dr. Langmuir's original theory of exploring electrodes, and it is clear that the conception of an electron temperature will have to be modified in certain cases.

It is interesting to notice that there are two distinct reasons why parts of a discharge tube may be non-luminous, or almost so. One is, that a sheath is present; and the other, that although in a plasma, which is usually brightly luminous, the discharge is being carried by diffusion, often in a reversed electric field, so that the electrons are not acquiring sufficient energy to excite or ionise the molecules of gas.

Calendar of Geographical Exploration

Sept. 27, 1874.—Crossing Western Australia

J. Forrest reached the overland telegraph line, which had been carried from Port Darwin to Adelaide in 1872, after a journey which began at Perth. He had followed the Murchison River and, after that, a line of springs. By August this source of water had given out, and it was with the utmost difficulty that he achieved his object and reached the line south of the Alberga River, thus completing the link between the coast lands of the west and the central regions. In 1869, Forrest had proceeded from Perth to the region west of Lake Barlee, and in 1870 had followed Eyre's route in the south, starting, however, from the west.

Sept. 28, 1791.—Coastal Surveys in Australasia

A French expedition under Bruni d'Entrecasteaux left Brest to search for La Pérouse. Surveys were carried out in Tasmania and New Caledonia, Bougainville Island was visited, and Amboina was reached through the strait between New Britain and New Ireland. The south coast of Australia was charted to 131° 30′ E., and the islands east of New Guinea, with the coast of New Guinea itself, were charted. Shortly after surveying New Britain, d'Entrecasteaux died. The explorer's careful work did much to fill in the details of this region of the Pacific. A competent scientific staff accompanied the expedition, the naturalist, Labillardière, afterwards publishing his records, while the hydrographers, Rossel and Beautemps-Beaupré, published the journal of d'Entrecasteaux and the charts of the coasts visited.

Sept. 30, 1500.—Brazil and the Mouth of the Amazon

Vicente Yanez Pinzon, who had formerly sailed with Columbus, reached Spain after a voyage which had been successful from the point of view of discovery, though two out of his four vessels were lost in a storm. He sailed in December 1499 from Palos, passed the Cape Verde Islands, and penetrated so far to the south-west that he lost sight of the pole star. On Jan. 20, 1500, he sighted the Brazilian Cape of San Agustin. Pinzon was the first to land on the American continent south of the equator, his farthest south being 8° 20′ S. In April of the same year the Portuguese, Cabral, also sighted the coasts of Brazil. Following the coast northward to the equator, he discovered the mouth of the Amazon, finding the water still fresh forty leagues out at sea.

Societies and Academies

LONDON

Institute of Metals * (Annual Autumn Meeting), Sept. 14.—**C. E. Ransley** and **C. J. Smithells**: Mechanical properties of nickel wires. The materials used include commercial nickel, refined nickel prepared by melting in hydrogen, and the same material with small additions of the elements commonly present in commercial nickel.—**H. J. Gough** and **D. G. Sopwith**: Atmospheric action as a factor in fatigue of metals. A review of the literature of corrosion fatigue reveals many apparent inconsistencies, but a closer examination indicates that such is not the case. It is shown directly that atmospheric corrosion enters, to a varied extent, into the mechanism of fatigue as exhibited during the usual type of fatigue test in which the surface of the specimen is exposed freely to the atmosphere.—**G. I. Taylor** and **H. Quinney**: The distortion of wires on passing through a draw plate. Composite copper wires $\frac{1}{8}$ in. in diameter, each consisting of two wires of semi-circular section, were pulled through various draw-plates. Photographs are reproduced showing the distortion of the cross-sections. These are treated in a quantitative manner, measurements of the ratio of distortion to increase in length being found for various reductions in area and angle of taper.—**H. W. Brownsdon** and **L. C. Bannister**: A modified impingement corrosion apparatus. Owing to difficulties experienced with apparatus hitherto used for carrying out impingement corrosion experiments, a modified apparatus has been devised which is simple in design and permits of the ready control of the many factors influencing this type of corrosion; details are given regarding its construction and use.—**W. H. J. Vernon**: The open-air corrosion of copper. (3) Artificial production of green patina. Treatment with ammonium sulphate solution followed by a solution in which basic copper sulphate is suspended gives a green patina, which, however, breaks down under severe weather conditions. A patina stable under the latter conditions is produced by anodic treatment for 15 minutes in a suitable electrolyte; it has a good green colour and is quite insoluble in water. Certain synthetic coatings other than basic copper sulphate, although initially green, readily blacken on free exposure to town air. The application of linseed oil, and more especially of lanoline, to the primary coating gives marked protection to the underlying metal, but does not prevent discoloration; water glass and silicon ester, on the other hand, appreciably increase the corrosion.—**K. L. Meissner**: Two years' corrosion tests with duralplat in the North Sea. The specimens consisted of strips of four different thicknesses, drawn profiles of two thicknesses, and riveted strips. With the exception of the last mentioned, all samples were exposed in two series, that is, at ebb and flow of the tide, and always under water. Samples were taken every three months.—**T. G. Bamford**: The properties of commercial varieties of copper at high temperatures. Five typical commercial coppers were examined. All these varieties were capable of resisting shock extremely well up to 400° C., and with one exception—that of tough-pitch arsenical copper—impact strength was well maintained up to 600° C. In general, nickel-copper has the greatest, and tough-pitch pure copper the least, capacity for withstanding alternating stresses at elevated temperatures, although the capacity varies considerably from one temperature to another. Nickel-copper has exceptionally high endurance at a temperature of 560° C.

PARIS

Academy of Sciences, Aug. 8 (vol. 195, pp. 405-428).—**Gabriel Bertrand** and **Georges Brooks**: The constitutional formula of laccol. The authors have obtained laccol in well-defined crystals, have prepared its tetrahydro-derivative, and have converted the latter into the diacetate. Laccol is a derivative of pyrocatechol, $C_6H_3(OH)_2C_{16}H_{29}$.—**J. Schokalsky**: The fluctuation of the arctic climate. Evidence that during the last thirty years the Atlantic current has carried an enormous mass of warm water into the polar basin. As a result, there is now a period of a milder polar climate.—**N. Cioranesco**: Some properties of polyharmonic functions in correlation with certain properties of polynomials.—**L. Tchakaloff**: A property of trigonometrical polynomials.—**F. Marty**: The group of automorphy of certain integral functions.—**A. Silveira** and **E. Bauer**: The Raman effect in saline solutions.—**Duffieux** and **Léon Grillet**: A sensitometric arrangement with cylindrical lens and dia-

* Continued from p. 446.

phragm in profile.—**Léon Gion**: The photochemical oxidation of aqueous solutions of ammonia. Ammonium nitrite results from the oxidation, and this is decomposed photochemically.—**Astruc and Mousseron**: The double sulphate of aluminium and sodium. The existence of sodium alum is clearly proved, but it is only a true double salt between the temperatures 11° C. and 39° C.—**V. Frolow**: The condition of the dissolved salts in the waters of the rivers of the Damas region.

CRACOW

Polish Academy of Science and Letters, June 11.—**Georges Bouligand**: The essential isolated singularities of a harmonic function and various associated problems.—**S. Mazurkiewicz**: Ensembles of unicity.—**S. Szczeniowski**: The probability of the passage of an electron in a region of negative energy.—**Mlle. J. Goworecka and M. Hlasko**: The electrolytic conductivity of the alkali metal hydroxides in water and the mobility of the hydroxyl ion. The limiting conductivities of lithium, sodium, and potassium hydroxides have been determined, the values found being higher than those generally accepted.—**K. Dziewoński and Cz. Piasecki**: Syntheses of the monosulphonic derivatives of acenaphthenequinone.—**K. Dziewoński and Mlle. Z. Zalewska**: A new method for the synthesis of dinaphthopyrone.—**A. Swaryczewski**: The *d*-tartrate of guanidine: crystallographic study.—**J. Zerndt**: An attempt at the determination of the age of the blocks of coal from the Carpathian Flysch by means of the megaspores.—**W. Tad. Dominik**: The relation between the formation of crystals of calcium oxalate in certain Coniferæ and the fall of the leaves.—**Z. Kolodziejski**: Study on the regeneration of the pedal disc in *Actinia equina*.—**J. Zaćwilichowski**: The innervation and the sensitive organs of the oviscapt in *Allantus arcuatus* (Tenthredinoidea).

GENEVA

Society of Physics and Natural History, June 2.—**Ch. H. Wakker and E. Briner**: Researches on the chemical action of electric discharges: improvements in yields realised by using light metal alloys as electrodes. The presence of alkali or alkaline-earth metals in the electrodes of arc furnaces considerably increases the energy yields in the production of various substances, especially nitric oxide.—**Ch. H. Wakker, E. Briner, and H. Paillard**: Researches on the production of nitric oxide in an arc furnace working with electrodes of light metal alloys. The improvements in the energy yields in the production of nitric oxide by means of the arc realised by incorporating small proportions of the alkali or alkaline earth metals in the electrodes are reproduced in a furnace using 2-4 kilowatts and with arcs 40-60 cm. in length.—**A. Lombard and A. Coaz**: The limit between the Jurassic and the Cretaceous from the Col des Aravis to the Col du Sageroux, Haute Savoie. The authors have recognised the existence of a zone of passage in the fauna of which the true Jurassic forms progressively disappear. There is no clear-cut line between the two periods.—**D. Zimmet and Ch. Yung**: The difference between the nitroprusside reaction for glutathione and acetone: the effect of the hydrogen ion concentration. Sodium nitroprusside gives a rose-violet colour with glutathione and with acetone, but whilst the first reaction is produced immediately and reaches a maximum at *p*H9, the reaction with acetone is not produced with *p*H less than 9 and is slow between *p*H9 and *p*H10. Reagents are proposed for detecting glutathione even when acetone is present.—**D. Zimmet**: A new reaction of glutathione. Oxidised glutathione, like cystine, gives a persistent rose-violet coloration with silver nitrate and dimethyl-*p*-phenylenediamine. These two reagents alone give only a fugitive tint. Reduced glutathione prevents any coloration, unless it is first left in contact with silver nitrate.

ROME

Royal National Academy of the Lincei, April 3.—**F. Severi**: A fundamental property of the fields of holomorphism of an analytical function of one real variable and one complex variable.—**P. Burgatti**: A classification of the linear equations of the second order to the ordinary derivatives founded on recurrent relations.—**G. Fubini**: A theorem on the equations to the partial derivatives of elliptic type which generalises a theorem of Hartog and one of Severi.—**M. La Rosa**: The supposed reality of the Lorentz contraction and the determination of the absolute motion of the earth.—**A. Pochettino**: The Hallwachs effect of compounds of elements with two-fold valency. Whereas, in general, Mn^{III} and Mn^{VII} ions tend to undergo transformation in the light into Mn^{II} and Mn^{VI} ions respectively, manganous hydroxide becomes changed into manganic hydroxide. Whilst calomel shows a tendency to become converted in the light into corrosive sublimate, this undergoes the reverse change under similar conditions, so that an equilibrium is established between the two; the same thing happens with cuprous and cupric chlorides. In general, with various pairs of analogous compounds, the greater Hallwachs effect is always shown by that compound in which the element of variable valency has the lower valency, independently of the sign of the ion in which the element appears.—**M. Betti and P. Pratesi**: Chemical constitution and rotatory power: Derivatives of chloro- and bromo-benzaldehydes. The anomalies displayed in the values of the dissociation constants of chloro- and bromo-benzoic acids are reflected in the rotatory powers of corresponding aldehyde *o*-derivatives. Thus, the dissociation constants of benzoic, *o*-chloro-, and *o*-bromo-benzoic acids are 0·006, 0·132, and 0·145 respectively, and the molecular rotations of the compounds formed by benzaldehyde, *o*-chloro-, and *o*-bromo-benzaldehyde with *d*-β-naphtholphenylaminomethane are +373·1°, −128·4°, and −308·7° respectively. Similar results are furnished by the meta- and para-derivatives, all the data indicating that, in these compounds, bromine is distinctly more highly electro-negative than chlorine.—**U. Broggi**: Complete linear differential equations with constant coefficients.—**A. Masotti**: Relations between the curvatures of two corresponding lines in a conform representation.—**J. Rey Pastor**: Topology of the dominions of a space of n dimensions.—**P. Rocher**: Lines of greatest slope of Green's function. The fact that the arc of greatest slope of Green's function, passing from the pole A to any point B of the domain, does not depend symmetrically on A and B, is extended to Euclidean spaces of more than three dimensions.—**Ruy Luis Gomes**: The existence of the normal derivative of a simple layer potential.—**L. Campedelli**: Certain noteworthy double planes with curve of branching of the tenth order.—**G. Palozzi**: Some results of projectivo-differential geometry.—**G. Colonnetti**: Influence of the shearing force on the deflection of a beam. Mesnager's statement that the elastic deflection of an inflected beam does not depend on the shearing force, is shown to be erroneous.—**A. Rosenblatt**: Laminary movements of incompressible viscous liquids (4).—**A. Occhialini and L. Gallino**: A reproducible sphinterometer for quantitative spectroscopy. For quantitative spectroscopic purposes, use may be made of the fact that a radiation emitted, on the passage of a spark, from a metal contained in an electrode is derived from a region adjacent to the electrode and of length varying with the richness in

the electrode of the metal considered. The instrument described depends on this principle.—**P. Straneo**: Energetic tensors in the unitary theory of absolute geometrisation.—**G. B. Bonino** and **P. Cella**: Raman spectrum of certain derivatives of aniline. The presence of a C : N linkage in a molecule results in the appearance in the Raman spectrum of one or two lines between 1400 cm.$^{-1}$ and 1500 cm.$^{-1}$. These lines cannot be confused with the lines 1430 cm.$^{-1}$-1450 cm.$^{-1}$ of the CH_2 group, which does not occur in the compounds examined.—**G. B. Bonino** and **P. Cella**: Raman spectrum of Δ^2-dihydronaphthalene. This spectrum exhibits lines in complete accord with the structural formula, if the spectra of naphthalene, decaline, and tetraline are taken into account. The line 3041 cm^{-1} of the aromatic C-H group occurs also with tetraline and naphthalene, and the lines 2873 and 2825 observed are attributed to CH_2. The line 1663 is lacking with tetraline, decaline, and naphthalene and is characteristic of the double ethylene linkage; the line 1433 is the characteristic CH_2 line but is displaced by 20 units from the typical CH_2 line.—**G. Piccardi** and **A. Sberna**: Molecular spectra and spectroscopic analysis (4): scandium. The method previously described allows of the ready and certain detection of 5 parts of scandium per 100,000, its superiority over ordinary spectroscopic methods being confirmed.—**F. De Carli**: (1) Solubility of calcium gluconate in the presence of sodium phosphate and of arsenious acid. Sodium phosphate has a less effect than boric acid in increasing the solubility of calcium gluconate, the most concentrated solution obtainable containing 7·26 per cent of the gluconate and 41·62 per cent of the phosphate. A 5 per cent solution of arsenious anhydride dissolves 9·29 per cent of the gluconate.—(2) Properties of solutions of calcium chloride and urea. Mixed solutions of calcium chloride and urea contain no molecular associations detectable by the physical methods employed. The therapeutic behaviour of such solutions does not appear to be attributable to specific properties of the compound, $CaCl_2$, $4CO(NH_2)_2$, $2H_2O$, but is probably due to an influence of the urea on the inconveniences sometimes accompanying the hypodermic administration of calcium chloride.—**T. Carpanese**: Granite, vesuvian, ilmenite, and titanite from Monte Rosso di Verra (Monte Rosa group).

VIENNA

Academy of Sciences, June 30.—**Richard Weiss** and **A. Beller**: Condensation of $\alpha\alpha'$-diphenyl-$\beta\beta'$-benzofuran with unsaturated compounds.—**Heinrich Graven**: A method for determining uranium and thorium in minerals (2).—**Heinrich Gräven** and **Gerhard Kirsch**: The radioactivity of early pre-Cambrian granites from southern Finland. Non-metamorphic intrusions appear to be moderately homogeneous as regards radioactivity, although specimens of outstanding activity occasionally occur. The results obtained with these granites are, in general, comparable with those found by Mache and Bamberger for the central gneiss of the Alps.—**Hans Pettersson** and **Josef Schintlmeister**: Atomic fragments of small range from rare gases.—**Georg Koller**: A synthesis of methyl diacetylevernate and of methyl tetra-acetylgyrophorate.—**F. Lauscher**, **F. Steinhauser**, and **M. Toperczer**: Profile of the intensity of the sun's radiation through the Styrian and Lower Austrian Alps. At the time the observations described were made (July 30-Aug. 2), the atmospheric dew of the E-N-E. air-movement led to the formation of a layer of vapour at the cumulus level over the whole pre-Alpine region. Hence the intensity of the solar radiation in the higher parts of the pre-Alpine district was somewhat below that of the inner Alpine valleys. At medium heights (about 1000 metres), the mountain air weakened the radiation about ten times as much as absolutely pure air, this observation agreeing with those made elsewhere. At about 700 metres the weakening was fifteen-fold and at 450 metres twenty-two-fold.—**H. Kun** and **H. Burchardt**: Non-specific actions of the female sexual hormone (progynon). With senile or prematurely old male rats, regular subcutaneous injection of progynon has the same effects as with the females: growth of hair on bald or thin regions and increase of the contents of hæmoglobin and red corpuscles in the blood.

Official Publications Received

BRITISH

The British Mycological Society Transactions. Edited by J. Ramsbottom, B. F. Barnes and H. Wormald. Vol. 17, Parts 1 and 2, 11 August. Pp. 156. (London: Cambridge University Press.) 15*s*.

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 64: The Ripening and Transport of Bananas in Australia. By Prof. W. J. Young, Prof. L. S. Bagster, E. W. Hicks and F. E. Huelin. Pp. 52. (Melbourne: H. J. Green.)

Transactions of the Mining and Geological Institute of India. Vol. 26, Part 4, June. Pp. 277-347 + xii + plates 27-33. 4 rupees. Vol. 27, Part 1, July. Pp. 86. 4 rupees. List of Members, 1932. Pp. 26. (Calcutta.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 71, No. 428, August. Pp. 285-404+xii. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Journal of the Royal Statistical Society. New Series, Vol. 95, Part 3. Pp. viii+393-606. (London: Royal Statistical Society.) 7*s*. 6*d*.

Report and Balance Sheet of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein) for the Year ending 31st December 1931. Pp. 31. (Kirstenbosch.)

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 4, No. 1, March. Compiled by Agnes Elisabeth Glennie. Pp. iv+135. (London: H.M. Stationery Office.) 2*s*. 6*d*. net.

Journal of the Society of Glass Technology. Edited by Prof. W. E. S. Turner. Vol. 16, No. 62, June. Pp. xii+33-68+111-253+139-290+xxiv. (Sheffield.) 10*s*. 6*d*.

Report of the Progress of the Ordnance Survey for the Financial Year 1st April 1931 to 31st March 1932. Pp. 19+6 plates. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1437 (T. 3157): Pitot-Static Tube Factor at Low Reynolds Numbers. By E. Ower and F. C. Johansen. Pp. 28 + 10 plates. (London: H.M. Stationery Office.) 1*s*. 6*d*. net.

Scottish Society for Research in Plant-Breeding. Report by the Director of Research to the Annual General Meeting, 26th July 1932. Pp. 29. (Edinburgh.)

FOREIGN

Norges Svalbard- og Ishavs-Undersøkelser: Meddelelser. Nr. 12: i. Norske Undersøkelser ved Sydpollandet 1929-1931; ii. *Norvegia*-Ekspedisjonen 1930-1931. Av Gunnar Isachsen. Pp. 345-366. Nr. 13: Norges Svalbard- og Ishavs-Undersøkelsers Ekspedisjoner Sommeren 1930; Ekspedisjonen til Jan Mayen og Østland, av Anders K. Orvin; Ekspedisjonen til Svalbardfarvannene, av Rolf Kjær; Ekspedisjonen til Spitsbergen, av H. Frebold; Ekspedisjonen til Franz Josefs Land, av Gunnar Horn. Pp. 367-405. Nr. 14: The Fossil Wood from the Tertiary at Myggbukta, East Greenland, by Ove Arbo Høeg; A Fossil River Bed in East-Greenland, by Anders K. Orvin. Pp. 363-474+8 plates. Nr. 15: Landets Senkning i Nutiden på Spitsbergen og Østland. Av Thorolf Vogt. Pp. 563-574. Nr. 16: Blütenbiologische Beobachtungen aus Spitzbergen. Von Ove Arbo Høeg. Pp. 22. Nr. 17: Notes on some Arctic Fossil Wood, with a Redescription of *Cupressinoxylon polyommatum*, Cramer. By Ove Arbo Høeg. Pp. 9+3 plates. (Oslo: Jacob Dybwad.)

Union Géodésique et Géophysique Internationale. Quatrième Assemblée Générale, Stockholm, Août 1930. Procès-verbaux des séances de la section de Météorologie. 1: Actes de la Section. Pp. 67. (Paris: Impr. Paul Dupont.)

University of California Publications in American Archaeology and Ethnology. Vol. 31, No. 4: Quantitative Expression of Cultural Relationships. By H. E. Driver and A. L. Kroeber. Pp. 211-256. (Berkeley, Calif.: University of California Press.) 25 cents.

Proceedings of the United States National Museum. Vol. 81, Art. 7: Decorative Designs on Elden Pueblo Pottery, Flagstaff, Ariz. By Walter Hough. (No. 2930.) Pp. 11 + 10 plates. (Washington, D.C.: Government Printing Office.)

U.S. Department of the Interior: Office of Education. Bulletin, 1932, No. 2: The History of the Municipal University in the United States. By Prof. R. H. Eckelberry. Pp. viii+213+13 plates. Pamphlet No. 29: Official Certificates, Diplomas and Degrees granted in France. By James F. Abel. Pp. 14. (Washington, D.C.: Government Printing Office.)

Contributions to Palaeontology from Carnegie Institution of Washington. Papers concerning the Palaeontology of California, Oregon and the Northern Great Basin Province. (Publication No. 418.) Pp. iii+113+14 plates. (Washington, D.C.: Carnegie Institution.)

Publications de l'Observatoire Astronomique de l'Université de Belgr de. Mémoires 1, 1932. Pp. 47+3 planches. (Beograd.)

Ber ens Museums Årbok, 1931. Hefte 2: Naturvidenskapelig rekke. Pp. 54+67+5+20. (Bergen.)