NATURE

SATURDAY, JULY 20, 1929.

CONTENTS.

Editorial and Publishing Offices :

MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3116, Vol. 124]

The Future of Agriculture.

A REMARKABLE suggestion has lately appeared in certain well-informed quarters of the American press, namely, that there are far too many farmers, that there is even now considerable over-production of farm produce, with still greater potential risk of such over-production, and that the only real remedy, drastic as it may appear, is the return of millions of farmers and their families to city life and work—if it can be found. It is estimated that there are about 6,500,000 farmers now engaged on American soil, but only a mere fraction of these are really efficient, up-to-date, prosperous, and contented ; and the vast majority, more than five millions of them, have a desperate struggle to make a living. A vigorous agricultural deflation programme is seriously recommended.

It is very doubtful if such a proposal, though backed by many plausible and at first sight very convincing arguments, will prove very acceptable either to the farmers themselves or to the general American public. The latter, from President Hoover downwards, has for at least twenty-five years past constantly and consistently called for a vigorous and far-reaching policy of 'back to the land'. It has, of course, always been firmly held by a certain and predominating type of mind, especially of the physiocratic sort, that a numerous and, if possible, prosperous peasantry or yeomanry is a basic factor in national strength and balance ; and if, as is generally assumed, it be the only or the most important source of the stronger and more vigorous elements in national life, there is much to be said in its favour. However, the most favourable ratio between town and country, between the agricultural and industrial parts of the population, is a highly complex problem and cannot be fully discussed here ; although one may pertinently inquire if England, for example, is weaker because nine-tenths of its population is urban.

In America it has scarcely been seriously questioned that a large farming community is a necessary condition of strength. 'Back to the farm' has been a national cry, despite the terrible crisis of 1920–21. The farmers have been looked upon as constituting one of the largest and most valuable parts of the home market : a view which has also been consistently held in Great Britain, not without a tinge of envy at America's supposed very favourable position in this respect.

This complacent state of mind has now suffered a severe shock. Of the 6,500,000 farmers in the United States, it is alleged that only about one-

eighth, or say 800,000, have taken full advantage of the most advanced scientific methods and use of machinery. The others, constituting the vast majority, are, it is stated, hopelessly inefficient and on the brink of destitution and ruin. If this be true, it is a really remarkable state of affairs in view of the present position of agricultural education, both in theory and practice, in the U.S.A. After so many years of continuous and high pressure endeavour on the part of nearly every responsible person in America—statesmen, economists, social reformers, educationists, the all-powerful ubiquitous press—to foster and perfect agricultural education and bring the benefits of the latest research to the most remote corner of the country, is it possible, one may well inquire, that five million American farmers remain inefficient and unprosperous? Further, what have the makers of farm machinery, of concentrated fertilisers, of improved, selected seeds, and other farm requirements, been doing all this time?

The worst of the tale is, however, not yet unfolded. Over-production with low price level is held to be the root cause of the American farmer's plight to-day, and notwithstanding the voluminous flood of legislation, aiming at his assistance and relief, starting with the Fordney Emergency Tariff Bill and finishing up with the luckless and oft-defeated McNary-Haugen Bill, and the more recent and ambitious Farm Board proposal, there is little hope of real remedy except in a drastic reduction in the number of farmers. At least that is the view which appears to be gaining ground in some quarters. Then, if this be so, not only are we to believe that the great majority of American farmers are backward and inefficient, but also that it is, in a sense, fortunate that they are so! If all of them became as up-to-date as the small minority, then production and output would reach such vast proportions, and prices would fall to such extremely low levels, that the plight of the farmers would be far worse than it is now.

A pretty dilemma, to be sure, and a very curious paradox; not exactly gratifying to the protagonists of agricultural research and of improved methods, or to the sellers of machinery and fertilisers. It forms a strange commentary also on Sir Daniel Hall's presidential address on food and population to Section M (Agriculture) of the British Association in 1926. As a specific illustration the case of wheat has been taken. The present production of wheat in the U.S.A. is about 800,000,000 bushels per annum, which means a low average yield of no more than 13 bushels to the acre (as compared with about 32 in England and 41 in Denmark). Of this amount, about 200,000,000 bushels is exported. It is assumed, perhaps a little rashly, that under improved methods the yield per acre could be doubled. Modern science can doubtless do much, but still the law of diminishing returns is even so not yet quite obsolete and still operates though sometimes very much in the background; and it does appear a rather hazardous assumption to suppose that the yield of American wheat per acre could be doubled and at a lower or equal unit cost. But without quibbling about the precise increase possible under better methods, even a 50 per cent increase would be disastrous, since there is already over-production with present yields.

The further assumption is made that no great extension of demand is possible either in the home market or in the export trade. The American citizen is not likely to be able or willing to eat more, and in fact the modern tendency under the latest nutrition and hygienic teaching is to eat less, so that the branches of agriculture devoted to the production of human food cannot look for much increase in demand in the home market. As for the export trade in food, this is already declining in the direction of Europe, and despite recurring famines and a more or less chronic state of malnutrition near approaching starvation in many parts of India and China, these poverty-stricken parts of the world cannot afford a larger share of American agricultural abundance at prices satisfactory to the American farmer. In regard to the production of raw material, such as cotton, it is likewise assumed there is little prospect of substantial increase in demand.

It is therefore concluded that the only true remedy is a large reduction in the number of farmers. Whether this means that the farms so abandoned are to go out of cultivation or are to be absorbed by the minority of efficient and prosperous farmers is not quite clear; but apparently the great bulk of the land would have to go out of cultivation, since, if worked by the successful farmers, output and over-production would be on so vast a scale as to be unthinkable. It might be possible, perhaps for a few of the inefficient farms, say up to 100,000, to join the present 800,000, but no more. Hence the only possible solution appears to be the removal of about 5,000,000 farmers from their present homesteads to the cities, that is to say, an exodus from farm to city of approximately 14,000,000 persons.

It looks as if such a drastic 'remedy' would involve greater problems and difficulties than those

already existing. It is pointed out, however, that the absorption by manufacturing industry in the cities of such a vast number would not be more difficult, if spread over a period of ten or more years, than the like absorption of about one million immigrants from Europe every year before the quota policy was introduced. Also, there is already in evidence a certain migration of population from the country and farm life to the towns, especially since the disastrous farming years 1920 and 1921. It is estimated that, since those years, about four million persons have returned to the cities; and if immigration could be still more rigorously restricted, this transfer could be greatly accelerated.

The position of American agriculture, as above described, contrasts strongly with the interesting thesis discussed by Sir Daniel Hall in his presidential address to which reference has already been made. In that address he presented data showing that the average consumption of food and raw material by white peoples requires from 2 to 2½ acres per head; also that the white population of the world is increasing at the rate of about five million per annum, involving a commensurate increase in cultivated land of 12½ million acres per annum, or alternatively a proportionate increase in yields on the existing area, since there are no new areas worth speaking of to be opened up. The only way to meet the enhanced demand for farm produce is by means of more intensive culture, more scientific methods, and in particular the much more considerable use of synthetic fertiliser.

This, of course, may still remain true as the expression of a general tendency for the greater part of the world which is bound to operate in the long run; but if the American position is really that which has just been described—namely, overproduction even though the great majority of the farmers are producing at a very low level—then it would seem that the general rule enunciated by Sir Daniel Hall appears to be subject to substantial local or temporary checks; although, on the other hand, it is quite possible that the American position has not been quite correctly diagnosed, and certainly some rather large assumptions have been made. One may yet conclude that the bounty of Nature and science is far greater than we have ever envisaged in our wildest dreams, that the law of diminishing returns may be suspended almost indefinitely, and that there is—and will be for some time—an economic limit to the extent to which the world, as a whole, can employ the mighty powers and resources of modern science in the realm of agriculture.

A Philosophy of Biology.

Theoretische Biologie. Von J. von Uexküll. Zweite gänzlich neu bearbeitete Auflage. Pp. x+253. (Berlin: Julius Springer, 1928.) 15 gold marks.

THIS is a really great book, well worthy of close study not only by biologists but also by all scientific men. For is not biology the science of life, and the first and most fundamental question raised by that science is "What is life?" The author endeavours to look this question, and the other far-reaching questions which arise out of it, fairly in the face, and it is then seen that not only is biological science in the narrower sense involved, but also all other science of every description. Life is primarily our own existence, and secondarily the nature of other 'things' in which we suspect an existence in some respects at least similar to our own. The first problem presented, therefore, to biology is the analysis of our own existence.

All science, physics and chemistry no less than biology, consists in the study of 'phenomena', that is, of 'appearances' to our conscious minds, and the question to be settled is how much of the 'appearance' is due to the structure and working of the mind itself, and how much to an event independent of the mind. In endeavouring to answer this question, Uexküll affirms, and in our judgment quite justly, the soundness of the position taken up by Kant in the "Critique of Pure Reason". He endeavours to extend Kant's theses. Kant asserted that space and time, which enclose within them all phenomena, are 'forms' which our mind imposes on phenomena, and Uexküll not only reasserts this, but also adds to it that colour tone and odour are equally mental constructs, as are concepts of motion, including wave motion, and what the 'thing-in-itself' would be like when stripped of these mental accretions no human being can conceive. He scourges with just contempt the assertions of mechanistic biologists that mind is a name for the physical and chemical actions of matter, since all the qualities which make matter anything else than 'pure being' are conferred on it by mind.

Space is a general synopsis of our earliest fundamental experiences. Vision alone will not give us space, for the field of vision is spread out before the baby like a flat picture; it is only gained when to this experience are added the efforts of the eye-muscles and of the arms in reaching after objects. This space which thus summarises our muscular experience is always three-dimensional Euclidean space,

and this is the only kind of space for which there is justification: all other so-called kinds of space are merely mathematical juggling with symbols.

Time, again, reflects the nature of our experience, which always consists of phases succeeding one another, and is irreversible; any other conception of time is merely a mathematical fiction.

Colour experience forms a scale of values beginning with deep red and passing through yellow, green, blue, and violet to something suspiciously like deep red again. Tone likewise exhibits a series of values in octaves; taste includes only four fundamentals. Sensations of odour, too, when properly investigated, will likewise reveal a similar scale of values. We live in a human world largely built up by our minds, and we can no more escape from it than we can lift ourselves up by our own waistbands.

In studying other living beings, therefore, and especially animals, we must always bear this limitation in mind. It is wrong, Uexküll asserts, to say there is one sun; there is a human sun, a lion's sun, and a fly's sun, as well as many others—and there is no certainty in correlating these with each other. But our earliest essays in comparative biology are completed when we are children: we then learn to distinguish some of the 'appearances' as our own body, from the outside world, because from the body we get a double set of stimuli—we can not only see it and feel it, but also sensations of pain arise in it when it is too roughly handled. When the crural nerves of a rat are severed it will devour its own toes—they are for it edible material and part of the outside world. Secondly, we learn to recognise amongst other 'appearances' some that are the envelopes of similar minds to our own. This is the really great advance in biology; all other subsequent advances are small in comparison to it. Zoology is merely the extension of this discovery so as to recognise behind another set of 'appearances' a series of minds in some respects resembling our own but much simpler, and in fact forming a graded series in degrees of simplicity.

Since our minds are awakened by stimuli received through the sense organs and express themselves in actions carried out by our muscles, we can hazard some kind of guess as to what the minds of animals must be like, in so far as we note a similarity between their sense organs and ours and a similarity between their effectors (muscles) and ours. As Uexküll expresses it: "Every animal is a subject which, thanks to its peculiar structure, selects from the general action of the outer world certain particular stimuli to which it responds. These responses consist in reciprocal actions on the outer world and these actions alter the stimuli: thus arises a circle which may be called the functional circle of the animal. The sum of the stimuli which act on the animal constitute a world; the stimuli shape themselves into objects (*Merkdinge*) which cause the animal to direct its motions, just as objects perceived at sea make the helmsman port his helm. The objects taken together may be termed the 'world of perception'. The conscious directive actions exercised by the animal on its movements form its 'inner world'. The movements themselves form a 'world of action'. The 'world of action' and the 'world of perception' taken together constitute the environment."

It is, of course, the aim of physiology to compare animals to machines and thus to explain as much of their actions as possible. This doctrine is heavily attacked by Uexküll. He points out that in every conceivable machine there are two elements, namely, the material out of which it is made and the framework of fixed parts by the reciprocal movements of which its movements are effected. So long as the framework is relatively rigid, the material out of which it is constructed is unimportant. But in the living organism there is no distinction between framework and material; the two pass uninterruptedly into one another; the living substance constructs the framework and can dissolve it. This is most strikingly shown by the simplest animals, such as *Amœba*, which may be justly said to be continually engaged in dissolving and then devouring their own framework. In the higher animals, every variety of framework, muscular, nervous, glandular, and supporting, takes its origin in similar cells made up of the same semi-fluid protoplasm as constitutes the body of *Amœba*. But the failure of the machine theory is most strikingly shown when we consider the development of the organism from the germ-cell.

As Uexküll shows with relentless logic, any mechanical theory of development, whether physical or chemical, necessarily involves an 'architecture of the germ-plasm', that is, a framework of different chemical substances in fixed relations to one another—a miniature replica of the framework of the body—and the discoveries of Driesch prove definitely and finally that such a framework does not exist.

Just as the deepest analysis of an animal's life leads to those 'conscious directive will-impulses' which are ultimate and make up its

'inner world' or psyche, so the study of development leads us back finally to a series of formative impulses succeeding one another, which Uexküll strangely confuses with the Mendelian 'genes'. The Mendelian 'genes' are simply names for aberrations or weakenings of the normal course of development. They are pathological in origin, as the recent work of Muller has proved, though it was fairly obvious from general considerations before. In the fresh-water shrimp *Gammarus*, on which Dr. E. J. Allen and Mrs. Sexton have carried out such thorough and painstaking investigations at Plymouth, there are no less than eight different kinds of germ-weakening or damage which will turn the normal black eye of the animal into a red one. But if we study the way in which the formative stimuli arise in a normal development which has been completely analysed, such as that of the sea-urchin, we find nothing remotely resembling Mendelian genes. The egg segments and gives rise to a ball of similar cells, and Driesch has proved that these cells are equipotential, each one of them having all the powers of the original cell, and if separated from its normal sisters and forced into a new position it is capable of producing any organ of the larva whatever. Then there comes a change: the protoplasm of one side of the ball can, by intucking, produce a gut—that of the other side cannot. Fresh potencies have been conferred on part of the protoplasm. The nuclei have not altered, all continue to possess the same number of chromosomes, but fresh emanations, most probably ferments, have been emitted into part of the protoplasm.

In later stages of development, Driesch has shown that at first any part of the gut will form a cœlomic vesicle, but that later this power is limited to the swollen tip, and if this tip be cut off, the truncated gut will heal but will produce nothing further. At a still later stage we ourselves have shown that a small segment of the cœlomic cavity known as the hydrocœle will act on the neighbouring skin so as to force it to produce the spines and tube-feet of the adult sea-urchin, and on the neighbouring mesoderm so as to compel it to produce the teeth and other ossicles of Aristotle's lantern. Thus the animal is built up, as Uexküll puts it, by a series of 'impulses' coming into action one after another which 'activate ferments' emitted from the nucleus.

If we examine more closely into the nature of these 'impulses', we find that each one of them is an imperfect repetition often repeated, in a word a blurred memory, of a former functional reaction of the organism to the environment, that is, a former *habit*, and so we discover that the impulses are memories of a series of habits superimposed one on another—a striking parallel on the corporeal side of the Freudian conception of the building up of the mind. It is to be regretted that Uexküll passes over almost completely the *historical* explanation of the structure and function of organisms which is embodied in the idea of evolution. No doubt he is led to this by his repulsion from the loose teleology implied in the Darwinian theory of natural selection. It is wrong, he says, to call one animal more perfectly adapted to its environment than another; the *Amœba* and the lion are equally well equipped to meet the calls which Nature makes on them: what is not well adapted belongs to the realm of pathology and not to biology (as incidentally do all mutations). When the environment changes, the animal within limits has the power of responding to the change, and the vigorous and healthy members of the species do so and pass on this power to their offspring; the 'random' variations in all directions, covertly assumed by Darwinism, simply do not exist.

It would far exceed the limits allowed by the most generous editor were we to attempt a full analysis of this wonderful book. No doubt each one of us who reads it will find something with which to disagree. We have indicated an important point where we are unable to see eye to eye with von Uexküll. We regret also very much that he still clings to the obsolete foam-work theory of protoplasm propounded by Bütschli, and that he accepts the crude theory of the purpose of 'eye' spots on the wings of peacock-butterflies as marks to deceive attacking birds. We have stood in a lane in Cornwall in August with a gorgeous array of admirals, peacocks, tortoise-shells, and other gaudy butterflies on the hedgerows on either side; the air was cleft with the arrow-like flight of low-flying swallows, and they molested the butterflies no more than we did.

Uexküll finds his deepest insight into the nature of life in the conception of *Planmässigkeit*, which we may perhaps translate as 'purposeful striving', and so it turns out that he has independently come to the very same conclusion as our comparative psychologist, William McDougall. Driesch's 'entelechy' is only another way of saying the same thing. Uexküll has earned the right to his opinion by a long series of brilliant researches in comparative physiology. It behoves all who desire to get a thorough insight into fundamental problems to study his book. E. W. MACBRIDE.

Chemistry and Monographs.

The Pyrolysis of Carbon Compounds. By Prof. C. D. Hurd. (American Chemical Society Monograph Series, No. 50.) Pp. 807. (New York: The Chemical Catalog Co., Inc., 1929.) 12.50 dollars.

THE serial scientific literature of the world increases yearly in bulk, and the knowledge contained therein is cumulative. Of all the sciences contributing to this already vast ocean of fact, theory, and opinion, chemistry, in all probability, heads the list, because the field covered by it and its related subjects is greater than that of any other science. The recent issue, in five volumes, of the decennial index of the American Chemical Society came as a startling reminder of what it is now thought proper to include under the head of pure and applied chemistry, and constituted a warning to which other societies, dealing with the publication of chemical abstracts, must have regard. It showed, moreover, that although reference to the original literature is essential to workers in connexion with their activities in some particular field, it cannot be regarded, except in special cases, as a practicable proposition for those who wish to keep abreast of development in sections other than those in which their own work lies. Views change, and much of the published work is subject to correction and alteration as the outcome of further research; a cause of confusion which is enhanced at the present time by the premature publication of results and conclusions by the 'young man in a hurry'.

In earlier days a systematic text-book provided all that was required, and lecturers were in a position to cover, with fair completeness, the whole field of chemistry as then known. But nowadays lectures have to be confined to the enunciation and description of principles, and it is no longer possible for even the most comprehensive of text-books to cover the field of any one of the great branches of chemical science. Recourse had thus to be made to other methods, and in the monograph a means has been found by which it is possible to treat special branches of chemistry in an adequate and reasonably up-to-date manner, which seems to provide a definite solution of the problem. Nevertheless, it is evident that, for any series of monographs to be effective, it must be wisely distributed among the subjects most likely to lead to an understanding of the science as a whole and must not be too specialised in character, and it is clear that this has been the aim before the special committee of the American Chemical Society, under the auspices of which the volume under review has been issued.

It was in July 1919 that the Inter-Allied Conference of Pure and Applied Chemistry deputed to the American Chemical Society the task of producing and publishing scientific and technological monographs on chemical subjects, and it is thus ten years since the Society took over this trust. In that period the Society has issued fifty volumes, which, as a perusal of the publisher's list shows, cover a wide area and embrace a large number of subjects related both to technology and pure science. This is a great record, and one which must be a source of gratification to the Committee and to the Chemical Catalog Company, which has acted as publishers. The book under review is the fiftieth of the series and constitutes a worthy jubilee volume.

At first sight it might be regarded as dangerous to deal with a subject such as organic chemistry from the point of view of some particular behaviour which the substances described show. Conditions of pyrolysis are difficult to determine. There are so many variables which are not subject to complete control: Surface action and the presence of catalysts; secondary chemical changes leading to the formation of products remotely different from those initially formed; products formed by the internal condensation of unstable reactants. These and many other considerations render the field one of the most difficult in modern research. Indeed, it does not appear as if full agreement has yet been reached regarding the behaviour of so simple a substance as methane when subjected to the action of heat. Nevertheless, it may be said at once that the author has succeeded in producing a very readable book, in which, by allocating organic compounds to groups, he has recorded published observations on their behaviour on pyrolysis which, for the first time, enable the reader to see at a glance some of the important changes organic substances undergo in this connexion.

It will probably be a surprise to many people to realise the important part played by pyrolysis in organic chemistry and the wide application it finds industrially. The cracking of petroleum is, for example, one of the most important industrial operations carried out at the present time, and constitutes the means by which much of the petrol required for our modern high-compression engines is produced. Again, the wandering of groups, especially those attached to nitrogen, affords the means by which many of our important dye-stuffs intermediates are manufactured. In the book

under review, organic substances are treated in the order in which they are usually found in organic chemistry text-books; compounds being chosen to illustrate the characteristic behaviour of substances of each group. Whenever any kind of generalisation is possible, it is brought clearly to light, but it is evident that much of the information is disjointed and does not admit of systemisation in the light of our present knowledge. Indeed, it is doubtful whether definite generalisation is possible in the great majority of cases, in the absence of any information regarding the action of catalysts or the surface action of the containing vessel.

Nevertheless, the manner in which the author has searched the literature for examples of pyrolytic change is remarkable, and the bibliography will be found of the greatest value. The book will undoubtedly be of great service to research workers and students, for whilst the method of treatment is unusual, it is none the less thorough and presents the subject from a point of view which has not been hitherto attempted. Like all books issued by the Chemical Catalog Co., it is well printed and the formulæ admirable. J. F. T.

School Physics.

(1) *Light: an Introductory Text-Book.* By C. G. Vernon. Pp. vii + 191 + 2 plates. (Cambridge: At the University Press, 1929.) 3*s.* 6*d.*; with Exercises, 4*s.*

(2) *Intermediate Heat.* By Dr. R. A. Houstoun. Pp. ix + 112. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 3*s.* 6*d.*

(3) *Heat, Light and Sound.* By P. J. Lancelot Smith. (Dent's Modern Science Series.) Pp. 368. (London and Toronto: J. M. Dent and Sons, Ltd., 1929.) 5*s.* 6*d.*

(4) *Energy.* By Sir Oliver Lodge. (Benn's Sixpenny Library, No. 65.) Pp. 79. (London: Ernest Benn, Ltd., 1929.) 6*d.*

THREE of these books are concerned to meet the demands of the First School Examination. With the examination system bulking so unduly in secondary education, the continued making of text-books with this aim is not to be wondered at. Years ahead we may decide otherwise the fate of the would-be science text-books in that day. We may ask: Is this book a distinctive contribution to teaching practice? Will it, in Sir Humphry Davy's words "add some little to the quantity of human knowledge, and of human happiness"? Will it lay the foundation for that appreciation of Nature and her ways on which the growing generation can build with success? Many text-books to-day could claim to pass the first question: how many school text-books could pass them all? For now we must content ourselves with the first question. Each of the following three books meets it with success.

(1) "Light" merits attention. It is a workmanlike attempt to develop an introductory course based on the concept of light as a wave motion, and is well worth the study of those science masters who confine themselves too closely to the old and unappetising course of thinly disguised geometry. Both methods should, of course, find a place in modern educational practice, but in what proportion is a problem for the individual physics master. Further, in the last chapter is a list of suggested experiments using the excellent apparatus of Mr. F. A. Meier of Rugby, described in the *School Science Review*, September 1922, in which "rays fixed by means of pins" are replaced by more illuminating beams. Mr. Vernon finds difficulty, however, in giving the history of his subject. Actually he summarises it in his first chapter. There the beginner meets "Newton's most famous experiment of course is the analysis of sunlight into a coloured spectrum using a prism", something of Snell and Descartes and the law of refraction, the disproof of the corpuscular theory, and so on. The interesting material here would have appeared much better incidentally, or more naturally in a concluding chapter.

(2) This deserves to be a very successful class book. It presents the essential facts concisely, and is developed logically. Many physics teachers must have wished for such a book, which does not rob them of their classical anecdotes or of all their illustrations, but serves as a sound framework for adding all those little things which give class teaching its value. Within the limits of about a hundred pages, Dr. Houstoun has done excellently.

(3) Here, too, is a good text-book. It covers a little more than is needed for matriculation, and is very suitable for work in the two years before that examination, where it is considered advisable to use one text-book only. If supplemented by a good practical course, it can be recommended as a safe and sound book. In dealing with reflection from spherical mirrors on p. 202, an unfortunate prominence is given to the generalisation: "Real images are always inverted". The limitation that this is true of real objects should have been emphasised.

(4) "Energy" should be the well-thumbed possession of every sixth form boy, even though he

is not on the science side. Its author's rare gifts of exposition and illustration are amply illustrated in this little book, which Messrs. Benn have done well to add to their excellent series. It has the distinction, won by all too few physics books, of passing successfully our third question posed above.

A. J. WHITE.

Our Bookshelf.

Éléments d'histologie. Par Prof. P. Bouin. Tome 1 : *Cellule ; division cellulaire ; différenciation cellulaire ; classification morphologique et fonctionnelle des cellules, tissus et organes ; éléments de soutien, contractiles, nutritifs ; sang, lymphe, organes hématopoiétiques, vaisseaux sanguins et lymphatiques.* Pp. vii + 334 + 2 planches. (Paris : Félix Alcan, 1929.) 120 francs.

ALTHOUGH the major part of organic histology remains to be treated in a second volume, and does not come within the scope of this present notice, it may be said that there is now no treatise of medical and general histology which does for English students what this work by the distinguished professor at Strasbourg does for the French. The appearance of the work is a restraining influence upon the increasing detachment of medical training from biological actualities and a check upon the facile conceptualism which makes precise knowledge of the organism a matter of professional indifference. The work is inspired throughout by that 'esprit biologique' which the author deems to be the foundation of medical science, while recognising that his specialty "can no longer limit itself to the study of the minute anatomy of the mammals, but should aim higher and further, concerning itself with some of the questions which preoccupy the minds of inquirers at the present moment".

If the work thus revives a diminished biological faith, it also affords general access to recent accumulations of knowledge, not merely as addenda but also in their proper perspective as parts of an orderly whole. There may be cited the sections dealing with protoplasm from a physico-chemical point of view, microdissection methods applied to karyokinesis; tactisms and tropisms; up-to-date articles on ossification, on joints, on the blood, the blood-vessels, and on the reticulo-endothelial system. Excellent bibliographies are provided to guide the student.

Text-books are, unfortunately, necessary. It is not the fault of any one in particular, but the inevitable fault of all, that they give undue publicity to error. W. Glaser, in pre-War days, figured "fine nerves passing close to a capillary, itself surrounded by somewhat thicker, spirally-arranged nerves". The figure reappeared in Müller's "Die Lebensnerven". Krogh borrowed it for his work on capillaries. It became famous, and many thousands of students have seen it on the lecture-screen. It appears in the present work over the description : "nervous terminations about a capillary, showing the spiral course of nerve fibrils". The vessel is not a true capillary, and the 'nerve' has the familiar features of the spiral muscular loops around small arteries. Although hundreds of investigators must have seen appearances identical with Glaser's photograph, his description —the sole evidence for the double innervation of capillaries—has not hitherto been questioned. The demand for objective verification of physiological theories is responsible for the spread of such legends, but not entirely for their authorship.

TUDOR JONES.

From the Seen to the Unseen. By the Rev. John H. Best. Pp. xii + 552. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1929.) 18*s.* net.

THIS volume is an attempt to examine afresh the established facts and generalisations of modern science, and to ascertain how far such a consideration is capable of an interpretation in harmony with a belief in God as one who not only is absolutely good, but also is an active worker for the realisation of certain far-off beneficent ends.

The opening section of the book deals mainly with matters of a biological order. Mr. Best insists upon the failure to solve the details of embryonic development along the lines of pure mechanism, and in his psychological section he supports this view by pointing out how it would seem that the hypothesis of an inner principle of life is both desirable and necessary. Regarded from this point of view, the phenomena of life suggest to Mr. Best the existence of a supreme intelligence, and, arguing from similar premises, the theory is advanced that, in addition to intelligence and will, such human attributes as feeling and emotion may be added. Man's relation to the deity is then examined, and the conclusion is reached that, since the universe shows manifold indications of purpose in its later evolutionary stages, so the life of man suggests a purpose and a progress towards perfection.

Mr. Best's thesis is not new, but its freshness of treatment and sometimes originality of presentation may make it a valuable aid to those who, not content with a cautious agnosticism, prefer to seek support for their religious speculations in those departments of science which, from their very complexity, may not yet be sufficiently well understood to be described adequately in terms of the known.

The Annual of the British School at Athens. No. 28, Session 1926–1927. Pp. xi + 354 + 23 plates. (London : Macmillan and Co., Ltd., 1929.) 63*s.* net.

IN this volume we have a record of the operations of the British School of Archæology at Athens in the session 1926–27. In addition to the usual report of the Director and the accounts, it contains reports on the work which has been done by members of the School. The major operations continue to be the excavation at Sparta, where in the session of 1927 further work was carried out on the Theatre and the Acropolis. This is described by the Director, Prof. J. P. Droop contributing an

analysis of the native pottery from the Acropolis and Mr. W. Lamb a study of the bronzes from the Acropolis and the Orthia site. Mr. W. J. Forsdyke describes his excavation of the Mavro Spelio Cemetery at Knossos. These tombs were discovered in 1926, and the first five excavated by Sir Arthur Evans himself. From one of these came the gold ring with linear inscription described by him in the *Times* of June 8, 1927, in which he ascribed a talismanic meaning to the script. A paper of great interest is that by Mr. W. A. Heurtley on the excavation of a prehistoric site at Boubasta on the banks of the Haliakmon in Western Macedonia. The site, though small, was occupied over a very considerable period of time from the late Bronze Age. Not only is it interesting in itself as a hillside settlement, probably of seasonal nomadic shepherds, but it affords Mr. Heurtley the basis for a comparative study of the painted pottery of northern Greece from which he makes some suggestive deductions as to a possible source for the Dorian invasion.

Biology of the Vertebrates: a Comparative Study of Man and his Animal Allies. By Prof. Herbert Eugene Walter. Pp. xxv+788. (New York: The Macmillan Co., 1928.) 21*s.* net.

THE author states that his book is the outcome of twenty years' teaching of pre-medical students and others, and in regard to the latter he says: "It is not so generally realised that it may not be amiss for every man to gain some inside information about the human mechanism and how it came to be." That is the keynote of the book. In the first part of the book taxonomy, distribution of animals in space and time, the ancient history of man, cytology, histology, and embryology are considered, and there is a short concluding section on biological discords. The second part deals with the skin, alimentary tract, and with the circulatory, respiratory, excretory, and reproductive systems, and the third part with the skeleton, muscles, nervous system, and sense organs. In the second and third parts is given an account—necessarily concise—of the principal modifications of the organ or system under consideration met with in the vertebrate series, and due reference is made to functional activities.

To the student who has spent a year or so in zoology and desires to proceed further in the study of the comparative biology of the vertebrates, this book is a handy source of much interesting information which he would otherwise have difficulty in finding in small compass. Of the 687 text-figures a few are on too small a scale to be really serviceable. Of errors there appear to be relatively few, but *Xenopus* is not, as is stated, South American.

Ice Engineering. By Prof. Howard T. Barnes. Pp. vi+364+ii. (Montreal: Renouf Publishing Co., 1928.) 5 dollars.

TWENTY years ago, Prof. Barnes published his work on "Ice Formation with Special Reference to Anchor Ice and Frazil", and in the lengthy bibliography contained at the end of his new work on ice engineering will be found many papers by him on various aspects of the ice problem. His life-long study of the blocking of the rivers of North America by ice and of the icebergs of the North Atlantic, led him to the discovery of the value of thermit for breaking up great masses of ice, and in 1925 he was granted a patent by the United States for his process. Thermit, it will be recalled, was discovered in 1895 by Dr. Hans Goldschmidt, who died in 1923. It is a mixture of aluminium powder and iron oxide which, when ignited, produces intense heat in a very short time. As applied by Prof. Barnes, thermit has been used for clearing the streams leading to power houses, for the prevention of floods, and for the breaking-up of icebergs, and only last winter the Canadian Government entered into a contract involving an expenditure of some £12,000 for an experiment on a large scale for the prevention of ice-jams on the St. Lawrence.

Details of some of the work done by Prof. Barnes is given in this volume, which, however, also deals with the physical properties of ice, the theory of the formation of anchor ice, ice remedial work, ice navigation, ice breaking, and other aspects of the subject. The bibliography is classified and chronological and contains references to papers by Boyle, Gay-Lussac, Faraday, Forbes, Kelvin, and other famous investigators.

Handbuch der regionalen Geologie. Herausgegeben von Prof. Dr. G. Steinmann und Prof. Dr. O. Wilckens. Band 7, Abteilung 7a: *The Union of South Africa.* By A. W. Rogers, A. L. Hall, P. A. Wagner and S. H. Haughton. Pp. 232+3 plates. (Heidelberg: Carl Winters Universitätsbuchhandlung, 1929.) 17 gold marks.

THESE 'handbooks' are indispensable works of reference for the countries they describe. The first part of the seventh volume deals with the Union of South Africa. The sections by the four main authors are supplemented by contributions by Dr. J. L. Krige, Dr. du Toit, and Prof. Shand. The book, as might be expected from the authors, deals mainly with the work of the Geological Survey, and includes a useful list of its maps and publications. The work is shorter than the volumes by du Toit and Krenkel, and its special value is as an authoritative statement of the present conclusions as to the classification and correlation of South African rocks. It may be noted that the Stormberg Series is all included in the Trias; the system in which the Ecca Series should be included is left indefinite; and the Waterberg System, from which the beds below the unconformity in it are excluded and referred to the Transvaal System, is accepted as pre-Palæozoic.

The section that is of particular value is the account of the complex and long series of rocks included in the pre-Palæozoic. The economic section by Dr. Wagner has an interesting account of the occurrence and distribution of the platinum ores.

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.*]

Observations of the Total Eclipse of the Sun at Alor Star, Kedah, on May 9.

THE observations attempted by British observers at the total eclipse of the sun on May 9 were almost completely spoilt by cloud. At Alor Star in Kedah, the sky was covered throughout the day of the eclipse by high cloud through which the sun could generally be dimly seen. The prearranged programme was carried out, but the stars in the sun's neighbourhood did not show on the plates and the spectroscopic observations also failed.

Better success was obtained with the 6-inch lens of 45 feet focus which was used at Giggleswick, and the loan of which was extended by Mr. Worthington

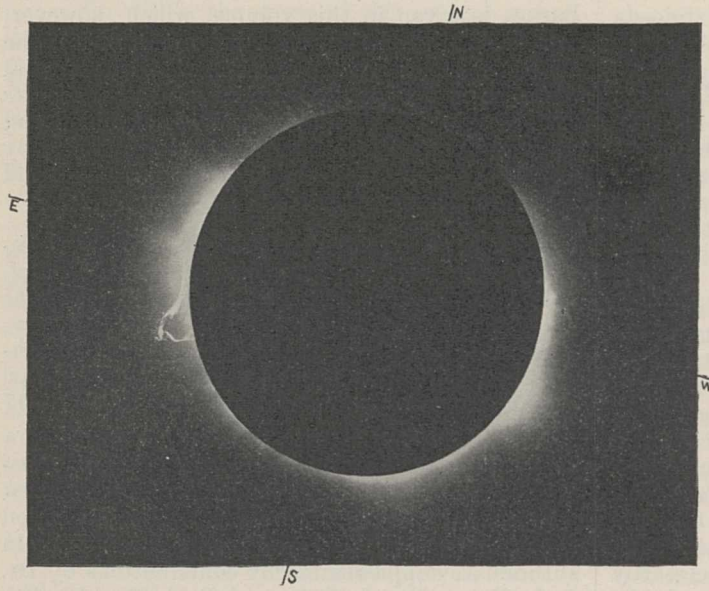

FIG. 1.

to this eclipse. The series of exposures from 3^s to 20^s were intended to show the prominences and the form of the inner corona. Although the longest exposure does not show more extension than was expected to be obtained from the shortest in a good sky, and although the longer exposures show a good deal of scattered light within the dark circle of the moon, the five plates give excellent pictures of the brighter details. The definition was excellent, such as it often is through cloud, and all the five plates show the same irregularities in the moon's limb. The reproduction (Fig. 1) is from the plate exposed from 200^s to 210^s after the beginning of totality. The filamentous prominence on the east limb is 180,000 miles long and 120,000 miles high—one of the largest ever photographed, though much inferior to that of 1919, especially in brilliance. The photographs taken near the beginning and end of totality show considerable differences in the structure of this prominence. On the western limb a beautiful coronal arch, besides much other detail, can be seen. The observers noted a considerable amount of red on this side of the eclipsed sun before the end of totality, but they did not see the large prominence on the eastern limb.

Small scale photographs were also secured through red filters. Those on kryptocyanine plates show the form of the corona best. The corona is of intermediate form and shows considerable difference from that generally obtained at sunspot maximum. On the panchromatic plates, also exposed through a red filter, the coronal extension is confused with the scattered light.

Photographic reproductions on paper 12 in. by 15 in., similar to those made from the photograph taken at Giggleswick, can be obtained from Mr. F. Jeffries, Royal Observatory, Greenwich, price 2*s*. 6*d*. each.

J. JACKSON.

Royal Observatory,
Greenwich, S.E.10, July 6.

A Possible Origin of Faint Fraunhofer Lines.

THERE are about 20,000 lines in the Fraunhofer spectrum of the sun (excluding the infra-red part), of which only about 6000 have been correctly identified with the lines of known elements, and with the lines of certain band spectra (cyanogen, Swan, etc.). The origin of the others is still wrapped in mystery. Possibly a large number may be found to coincide with the fainter lines of complicated spectra of elements like iron, nickel, etc., particularly with those belonging to higher Rydberg sequences. For some time past we have been thinking of a third possibility of the origin of these lines, namely, whether a large number may not be ascribed to the combined effect of Raman scattering and ordinary absorption. For example, molecules which are responsible for the emission of the cyanogen and Swan bands are strongly present in the sun, and when a beam of light falls on them from the photosphere, this light may be supposed to be modified by Raman scattering to the frequency $\nu - \nu'$, where ν' is some frequency corresponding to a strong vibration-rotation frequency of the CN-molecule. If $\nu - \nu'$ happens now to coincide with the H or the K frequency, the modified light will be absorbed by the high level Ca^+-atoms, and we shall get an absorption line in the place of the original frequency ν.

Taking the strong vibrational-rotational frequencies of the CN-molecule (particularly those which are expected to be strong at the solar temperature), I have calculated the lines which, after being modified by Raman scattering, are absorbed by the Ca^+-atoms. I have obtained lines which agree very closely with Fraunhofer lines of intensity $(-3, -2, -1)$ for both H- and K-lines. Some calculated lines coincide with the recorded faint lines of other elements. But even leaving these aside, the evidence obtained is strongly in favour of the view presented in this note. If we calculate the lines modified by such molecules as H_2, which are known not to occur in the solar spectrum, the coincidences are found to be either entirely lacking or rather poor.

Of course, in the circumstances, it is impossible to get absolute confirmation of the view, but probably a plausible case has been made out that Raman scattering may be responsible for the origin of a large number of faint Fraunhofer lines. If the view be correct, it will afford us a method for calculating the total number

of molecules of CN in the solar atmosphere from a comparison of the intensities of the modified line with that of the K-lines, with the aid of known dispersion formulæ.

It may be mentioned that this investigation was originally undertaken with the view of finding out whether some of the lines of the coronal spectrum may not be due to Raman scattering of strong Fraunhofer lines by molecules on the sun. Though certain striking coincidences were obtained, for example, the frequency of the green coronal line λ5303 comes out to be equal to $\nu - \nu'$, ν = frequency of the K-line, ν' is a strong vibrational-rotational frequency of the H_2-molecule, the corresponding modified frequency for the H-line was found to be absent, and hence the view was abandoned. It does not appear that the coronal spectrum is due to modification of strong Fraunhofer lines by Raman scattering.

My best thanks are due to Prof. M. N. Saha for kindly suggesting the problem and for his continual guidance.

DAULAT SINGH KOTHARI.
Department of Physics,
University of Allahabad,
June 1.

Fine Structure in the Helium Band Lines.

As is now well known, the electron levels of He_2 fall into two systems, p-He_2 and o-He_2, paralleling the p-He and o-He terms. The o-He_2 and p-He_2 levels are, on theoretical grounds, probably respectively triplets and singlets like the corresponding atomic levels (cf. especially W. Weizel, *Zeits. f. Physik*, **51**, 328; **52**, 175; **54**, 321; 1928–29). But no evidence of triplet structure in the o-He_2 levels has been reported, except probably in one perturbed 5π rotational level (cf. G. H. Dieke, NATURE, Mar. 23, 1929). This is not altogether surprising, since the o-He terms show only very narrow fine structures, the largest separations being in the $2\,^3P$ term ($^3P_0 - {}^3P_1$, $\Delta\nu = 0{\cdot}991$, $^3P_1 - {}^3P_2$, $\Delta\nu = 0{\cdot}077$).

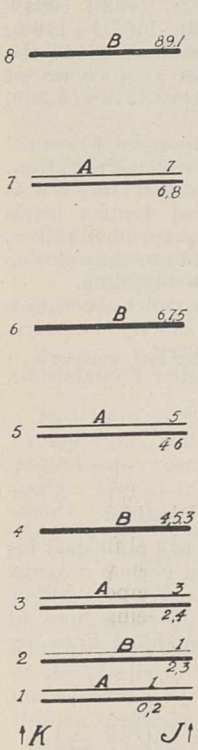

FIG. 1.

On photographing the He_2 bands with somewhat higher resolving power than hitherto, we have found fine structure in the lines of a number of o-He_2 bands having $2\,^3\pi$ as their lower electronic state. On the other hand, the $2\,^3\Sigma - 3\,^3\pi$ band λ4650 shows no evidence of fine structure.

The bands λ6400 ($2\,^3\pi - 3\,^3\Sigma$), λ4546 ($2\,^3\pi - 4\,^3\Sigma$), and λ5733 ($2\,^3\pi - 3\,^3\Delta$) all show qualitatively the same fine structure for all band lines which end on any given rotational level, but the quantitative separations appear to be smaller in some of the λ5733 lines. Other bands ($2\,^3\pi - 3\,^3\chi$ and $2\,^3\pi - 4\,^3\chi$) show similar relations.

We conclude that the observed band-line patterns are mainly determined by the fine structures of the rotational levels of the $2\,^3\pi$ state, and that the fine structures of the other states involved are smaller ($^3\chi$, $3\,^3\Delta$) or negligible (probably, $^3\Sigma$ states). The accompanying diagram (Fig. 1) shows the lower rotational levels of the $2\,^3\pi$ state, correctly spaced, but with the fine structures exaggerated twenty-five-fold. The fine structures shown are drawn the same as those observed for the λ6400 band lines. The doublet separations, as measured for successive A levels, diminish slowly from $\Delta\nu = 0{\cdot}34$ for the lowest level, but the intensity ratio (about 2 : 1 in favour of the high-frequency component) appears to be constant. For the lowest B level, $\Delta\nu = 0{\cdot}25$, with the long-wave component very weak, while succeeding levels are merely broadened.

The $2\,^3\pi$ fine structures may be interpreted as follows. If K is the rotational quantum number when the spin S is neglected, one expects for triplets ($S = 1$) a fine structure with three levels ($J = K, K \pm 1$), each having a statistical weight $2J + 1$. Suppose, for given K, the levels with $J = K \pm 1$ approximately fall together, while $J = K$ is distinct; the composite $J = K \pm 1$ then has twice the weight of the level $J = K$. This supposition explains well the observed relations in the A class of rotational levels. (This fine structure type is apparently similar to that observed in the $^3\Sigma$ normal state of O_2; cf. Mulliken, *Phys. Rev.*, **32**, 880; 1928: Kramers, *Zeits. f. Physik*, **53**, 422; 1929.) To explain the B level fine structures we may assume that $J = K$ and $J = K + 1$ approximately fall together for $K = 2$, while $J = K - 1$ lies higher; but that for $K = 4, 6, \ldots$ the three levels $J = K$, $K \pm 1$ are only sufficiently separated to give a broadening without resolved fine structure. The assumption made for $K = 2$ would give a 4 : 1 intensity ratio for the members of the observed doublet, in harmony with the estimated experimental ratio.

The Zeeman effect of these He_2 bands is also of interest. In a field of 30,000 gauss the Q (1) line of the λ6400 band becomes in parallel polarisation a doublet of width $\Delta\nu_n$, in perpendicular polarisation a corresponding triplet, the components being very sharp in each case. The unresolved patterns of the higher Q lines in parallel polarisation, and of the P and R lines in perpendicular polarisation, appear as doublets. The results are exactly what theory predicts for singlet levels (cf. Curtis and Jevons, *Proc. Roy. Soc.*, A, **120**, 110; 1928). The original fine structure is evidently wiped out here by a Paschen-Back effect.

Further details will be given elsewhere.

G. S. MONK.
R. S. MULLIKEN.
Ryerson Physical Laboratory,
University of Chicago,
June 1.

Use of the Thermionic Valve in Measurements of Ionisation Currents.

OWING to the extremely high humidity of the atmosphere in many parts of the east, the use of the quadrant electrometer for the measurement of ionisation currents is limited to a few months in the dry season. Recently we had occasion to demonstrate some of the ordinary experiments on the properties of ionisation currents, and found the following device quite satisfactory. In Fig. 1, AB is an ordinary ionisation chamber of which the upper plate A is connected to a battery of cells B_2, the lower plate B, on which is spread uranium oxide, being connected to earth through a high resistance R. This high resistance is inserted in the grid circuit of the valve V (Mullard type I.H.F.). Initially, with the key K open, the anode current is compensated by the potential balancing device Z, so that the galvanometer indicates zero. On closing the key the ionisation current flows through R, the grid potential is altered and the galvanometer is deflected. Varying the voltage on A, the ordinary increase of ionisation current up to saturation can thus be recorded.

The resistance R consists of a mixture of xylol and alcohol (10 : 1) contained in a sealed quill tube 20 cm. long. It had a resistance of approximately 10^{11} ohms as determined by the leakage method. Z would be, perhaps, 4000 ohms.

Experiments are now in progress to test the application of this method to the absolute measurement of ionisation currents. With a resistance of 10^{11} ohms a current of 10^{-12} amp. should produce a voltage on the grid of 10^{-1} volt, and hence an alteration of anode current for the type of valve used of about 20 microamp., which could be recorded on an

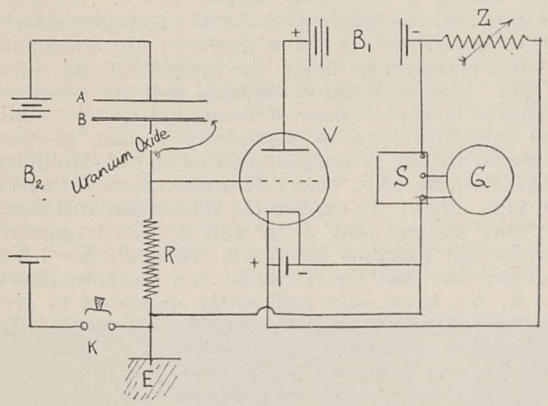

FIG. 1.

ordinary unipivot galvanometer. Still smaller ionisation current should be measurable with equal accuracy by employing still higher resistances. Whilst responding to the ionisation produced by X-rays, this method is unsuitable owing to the extreme sensitivity of the valve to high frequency disturbances. It is possible, however, that this difficulty may be overcome by careful screening. Unsteadiness due to capacity effects is very much minimised by operating the key from a distance. The possibilities of this method are now being investigated, and it is hoped to publish the full details in the near future.

I am much indebted to Mr. N. G. Srinivasan, who made the high resistances used and assisted me in setting up and carrying out the experiments.

J. A. C. TEEGAN.

University College,
Rangoon, April 21.

A Relation between Raman Spectra and Ultra-Violet Absorption.

IT is well known that the Raman frequencies are identified with vibration frequencies of the molecule, and this is corroborated by the agreement already found between Raman lines and absorption bands in the infra-red. It is to be anticipated, however, that a polyatomic organic molecule with its several frequencies of vibration would give a rather complicated absorption spectrum, so that the dispersion of the spectroscope in the infra-red is often insufficient for their resolution. The result is therefore a superposition of bands on a continuous background, the maxima of which may correspond to average values between two or more bands. In fact, the agreement between Raman spectra and infra-red absorption is in many cases not quite satisfying.

For the ultra-violet absorption spectrum of vapours the experimental conditions are better. Many organic substances yield absorption spectra consisting of well-resolved bands, and with the high dispersion available in this region, these can be measured with great accuracy.

Following up a suggestion made by Prof. V. Henri that the Raman spectra give the possibility of determining the vibrational frequencies of the normal state, a comparison was made of the ultra-violet absorption and Raman spectra of several compounds.

Chlorbenzol shows this relationship very clearly and was therefore chosen for a more complete study. The absorption spectrum of chlorbenzol vapour consists of numerous bands and lines (about 350 measured) extending from 2780 A. to 2250 A. Under the assumption that the strongest band in the spectrum is due to the electronic transition from the lowest level in the normal state to the lowest level in the excited state, a general analysis of the spectrum is possible by means of the Raman frequencies. From this band, $\nu_0 = 37052{\cdot}9$ cm.$^{-1}$; in the direction of longer wave-lengths there are a number of weaker bands at frequencies agreeing with the Raman frequencies. In the same way, going out from strong bands farther in the ultra-violet, which correspond to higher vibrational states of the excited molecule, similar weak bands are to be found toward longer wave-lengths, which again show separations equal to the Raman frequencies.

The frequencies measured in this way in the ultra-violet spectrum, compared with the Raman frequencies (in parenthesis), as measured in this laboratory are, in cm.$^{-1}$: 201·9 (196), 242·1 (242), 418·9 (420), 618·6 (618), 622·9 (618), 707·9 (706), 822·7 (823), 1004·8 (1005), 1024·6 (1025), 1087·1 (1088), 1157·2 (1162), 1585·0 (1583), 3063·3 (3064). The analysis of the spectrum shows that the strongest frequencies of vibration in the excited state are: 318·8, 519·0, 523·9, 929·8, and 962·6 cm.$^{-1}$.

The level corresponding to the Raman line 618 cm.$^{-1}$ is found to be double in the ultra-violet absorption, and the corresponding level in the excited state is also double. As the separation of these doublet levels increases proportionally with the quantum number, it is possible that an isotope effect due to the chlorine atom is the factor responsible for the doubling.

The complete analysis of the ultra-violet absorption spectrum of chlorbenzol will appear shortly elsewhere.

A. LANGSETH
(Fellow of the Rockefeller Foundation).
Physikalisch-chemisches Institut
der Universität, Zürich,
June 16.

Raman Effect in Carbon Dioxide.

IN NATURE of Feb. 9, F. Rasetti has published his observations on the Raman effect in carbon dioxide. He has found the lines at λ4639, λ4616 and λ4289, λ4268, excited respectively by the mercury lines at λ4358·343 and λ4046·560. These modified lines are due to the following transitions:

λ.	ν.	ν.	μ.	μ.
4358·343	22943·35	Diff. 1285·62	7·776	7·788
4616·000	21657·73			
4046·560	24705·40	Diff. 1281·80	7·799	
4268·000	23423·60			
4358·343	22843·35	Diff. 1393·00	7·177	7·168
4639·000	21550·35			
4046·560	24705·40	Diff. 1396·48	7·159	
4289·000	23308·92			

The lines thus correspond to an absorption band near about the region 7·8 μ, having for its components the radiations due to 7·788 μ and 7·168 μ. These components may be due to changes in the vibrational

states, one to a transition from state 0 to state 1, the other from state 1 to state 0. Both these states may be expected to occur under ordinary conditions when the moment of inertia of the molecule is large, as in the case of carbon dioxide.

These modified lines show that the model of carbon dioxide is a linear one as considered by Eucken (*Zeits. f. Physik*, **37**, 714; 1926), who has calculated the frequency corresponding to the vibration along the direction joining the C- and O-atoms to be of that of an anharmonic oscillator having a frequency corresponding to 7·86 μ—this frequency being optically inactive in the case of absorption. In the case of scattering, this frequency will evidently be the one which will be the most prominent. Of the other two fundamentals at 4·25 μ and 14·87 μ, one may be optically inactive in the case of scattering, and the intensity contribution of the other may be so feeble that it would require a very large exposure to show its presence. It may here be pointed out that the pair of bands at 2·7 μ, which has been considered as a fundamental by Schaefer and Phillipps, has been shown by Eucken as due to combination frequencies, and one is not justified in considering it as a fundamental due to its weak intensity. That the carbon dioxide molecule has a linear model is also shown by the absence of a permanent dipole moment and from the ordinary scattering data.

Thus the observations of Rasetti are a very clear proof not only of the Raman effect, but also of the linear model of carbon dioxide. It is also expected that in the other triatomic molecules where the dielectric constant data show the absence of a permanent dipole moment due to linear structure with symmetrical disposition of the two atoms on each side of the central one, the Raman effect would be shown evidently with less exposure for the optically inactive fundamental frequency in absorption.

P. N. GHOSH.
P. C. MAHANTI.

Applied Physics Laboratory,
University College of Science,
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Further Investigation on Incoherent Scattering in Gases.

IN letters to NATURE, and in two papers published in the *Proc. Nat. Acad. Sci.* of America, I have reported some results obtained on the Raman effect in gases. I want to report now about some new experiments, which will be more completely described in the *Physical Review*.

I have observed, for the first time, so far as I know, a purely electronic transition in the scattering process. The molecule NO has a normal ^2P state, the separation of the doublet being about 124 cm.$^{-1}$; the two levels arise from the two opposite orientations of the electronic spin relatively to i_1, that is, to the nuclear axis. I have found this transition in the Raman spectrum excited by λ2536.

I have built a new apparatus in order to work with gases at 10 atmospheres pressure, with ultra-violet excitation. In this way I have obtained beautiful Raman spectra of hydrogen. They show eight lines corresponding to purely rotational transitions, and also well-developed vibrational-rotational Raman bands, of which so far only unresolved Q-form branches had been recorded. I have measured now three lines of the Q-form branch, four of the RR-form branch, and one of the PP-form branch for the transition from the zero to the first vibrational level.

From this, not only the moment of inertia and the vibration frequency of the H_2 molecule can be calculated with high accuracy, but also the coupling between rotation and vibration.

Gaseous hydrocarbons at ten atmospheres give strong Raman lines in a few hours' exposure. Systematic work is being extended in this direction.

F. RASETTI.

California Institute of Technology,
Pasadena, June 1.

Statistics in Biological Research.

IN the review of Dr. R. A. Fisher's "Statistical Methods for Research Workers" in NATURE of June 8, the point is made that a careless reader may get the impression that the various methods outlined therein will give exact results when applied to the ordinary small 'sample', although we have, in general, no proof, or even expectation, that the sample is drawn from a 'normal' population, to which alone the tables can be exactly applied. That this is so is clear from the fact that an American writer has stated that the English school of statisticians claims to have produced tables which may be used for samples, however small, drawn from any conceivable population; but of course Dr. Fisher would be the first to cry out against the foolishness of making any such claim.

That such a misconception should arise is perhaps not unnatural when a mathematician is trying to explain what he has been doing to those who lack the mathematical outlook, but this would presumably not apply to the reviewer; yet by his use of the word 'admit' when doubtless he meant 'stress' ("It would seem wiser . . . to admit the incompleteness of theory . . .") he runs the risk of seeming to support a misstatement which Dr. Fisher may well resent.

The question of the applicability of normal theory to non-normal material is, however, of considerable importance and merits attention both from the mathematician and from those of us whose province it is to apply the results of his labours to practical work. Personally, I have always believed, without perhaps any very definite grounds for this belief, that in point of fact 'Student's' distribution will be found to be very little affected by the sort of small departures from normality which obtain in most biological and experimental work, and recent work on small samples confirms me in this belief. We should all of us, however, be grateful to Dr. Fisher if he would show us elsewhere on theoretical grounds what *sort* of modification of his tables we require to make when the samples with which we are working are drawn from populations which are neither symmetrical nor mesokurtic.

"STUDENT."

The Galton Laboratory,
University College,
London.

The Long Period Variations of UZ Persei.

IN *Harvard College Observatory Bulletin*, No. 867, Feb. 1, 1929, there is a note by B. P. Gerasimovič on "UZ Persei, a Variable of Unusually Long Period". The author found that the brightness of this variable star has two oscillations—short and long—with periods of about 90 and 907 days respectively. It is known that such oscillations are typical for μ Cephei.

In a short note (*Astronomical Bulletin*, Mirowedenije, Nr. 22, 1928) I showed from 3785 observations that μ Cephei has three oscillations. The periods of these oscillations are 90 days, 600 days and 13 years. The most interesting is the last oscillation, on account

of its long period and distinctly observed amplitude 0·5 st. mag.

It was interesting to look for this long period in the case of UZ Persei. Indeed, Mr. Gerasimovič's light-curve shows that the brightness at minima and maxima does not remain constant, but varies slowly.

It may be seen from the accompanying table that

Minimum I.D.	mag.	Maximum I.D.	mag.
2,417,450	10·85	2,416,800	10·56
8,300	10·90	7,800	10·55
9,200	11·00	8,700	10·62
2,420,200	10·88	9,700	10·57
1,100	10·72	2,420,800	10·45
2,000	10·75	1,550	10·48
..	..	2,400	10·52
Range	10·72-11·00	Range	10·45-10·62

there is a secular oscillation with a long period of about 5000 days or 14 years, and amplitude 0·3 mag.

It is clear that this star is of μ Cephei type. My paper on μ Cephei and the principle of classification of irregular variable stars of this type will be published later. W. ZESSEWITSCH.

University Observatory,
Leningrad, May 18.

Rapid Approximate Calculation.

FOR all work in which an error up to 10 per cent in the final result is admissible, the following rough logarithm-table provides a means of multiplying and dividing which is appreciably more rapid than direct calculation, and in simple cases does not require pencil and paper.

Log..	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
No. .	5/4	$\pi/2$	2	5/2	π	4	5	2π	8

With some of the figures, of course, everyone who has occasion to use logarithms at all is familiar; that the logarithms of $\pi/2$ and 2π can be obtained from that of π by subtracting or adding 0·3 is also in itself self-evident; nevertheless, it seems worth while to point out explicitly how very convenient it is to be absolutely familiar with the whole table. The error in every case is less than 1 per cent, and with a little practice it will be found possible also to estimate very quickly the second place of decimals for any number at all, with an error that is usually less than 1. An error of 4 in the second place, corresponding to 10 per cent in the number, should then occur only in the results of fairly complicated calculations.

An error in the decimal point is much less probable than when working with the slide-rule; the method is in fact very reliable for fixing the position of the decimal point in slide-rule results. Its principal other applications are obviously for estimating whether a theory or an experimental method is roughly suitable for a particular purpose, and for checking the experimental results of students in cases where a numerical slip is suspected.

R. D'E. ATKINSON.

Berlin, May 29.

The Spectrum of the Corona.

IN view of the interest attaching to the identification of the unknown lines of the solar corona, I have examined the possibility that they might be due to the occurrence of 'forbidden' transitions between terms in the spectra of ionised iron (Fe II), calcium (Ca II), titanium (Ti II, Ti III) and argon (Ar II), as well as several important forbidden transitions of the neutral titanium atom.

Ionised iron, calcium and titanium are all present at high levels in the chromosphere, and although there is no indication that argon is present, it was examined in consequence of a suggestion, now disproved by H. N. Russell and I. S. Bowen (*Astrophysical Journal*, **69**, 196; 1929), that the coronal lines might arise from neutral argon. Wave-lengths corresponding to some 500 forbidden transitions have been computed, but in no case have any coincidences been found between these and the coronal wave-lengths which would not be considered a pure matter of chance. Similar calculations seem to have been made by I. S. Bowen and D. H. Menzell (*Publ. Astro. Soc. Pac.*, **40**, 322; 1928), but details of this publication have not been available to me.

Another possibility that the coronal lines might arise in second type collisions involving the metastable 1δ terms of ionised calcium (Ca II) is under consideration, but has so far also yielded negative results. E. M. LINDSAY.

Department of Physics,
Queen's University, Belfast,
July 3.

The Ovarian Hormones.

THE writer of an article on "The Hormones of the Sexual Glands" in NATURE of June 15, p. 913, says that "the œstrous reaction of ovariectomised animals following an injection of 'œstrin' appears incomplete, in that copulation is only infrequently observed, and in the spayed bitch the hormone only produces symptoms of pro-œstrus, so that possibly the missing factor may be the hormone responsible for the initial development of the accessory sex organs". The reference is probably to a paper by Dr. S. A. Asdell and myself published in the *Proceedings of the Royal Society* (1927), but it is to be pointed out that the injections described in that paper were made into anœstrous bitches and not into spayed ones. The argument above quoted, therefore, does not apply. I write open to correction and without the references before me, but I believe I am right in saying that Dr. Wiesner of Edinburgh has concluded from experimental evidence that more than one ovarian factor is concerned in the production of pro-œstrum and œstrus. F. H. A. MARSHALL.

Beresford, Yarmouth,
Isle of Wight,
June 21.

THE paragraph to which Dr. Marshall refers was based on two statements made by Parkes in his review of ovarian activity (*Biol. Reviews*, vol. 3, pp. 212 and 213; 1928), quoting papers by Parkes, Fielding and Brambell (*Proc. Roy. Soc.*, vol. 101; 1927) and by Asdell and Marshall, the paper to which Dr. Marshall refers. Parkes found that of 92 induced œstrous periods in ovariectomised mice kept with males, only 7 were accompanied by copulation; of these 7, 3 occurred in mice which were found to have regenerated ovarian tissue. I had not referred to the original papers when writing the article and accept Dr. Marshall's correction. On the other hand, the failure of the injections in Dr. Marshall's experiment to provoke the full œstrous reaction surely indicates that a further factor is required, unless it is assumed that some inhibiting factor is present in the anœstrous bitch. THE WRITER OF THE ARTICLE.

Mineral Metabolism: Iodine and Sulphur.

THE importance of the mineral salts in nutrition is sometimes obscured by the greater attention devoted to other dietary constituents, more especially within recent years to the vitamins; but, of course, they are just as important for life as any of the other irreplaceable elements of the diet. The functions of the chlorides of sodium, potassium, and calcium in maintaining the osmotic equilibria between the fluids and cells of the body, without which the latter cannot function normally, the necessity of a supply of calcium and phosphorus for the formation of bone, and of iodine for the production of thyroxine, and the part played by the sulphur-containing amino-acid, cystine, in growth, all indicate the importance of studies of the mineral metabolism.

The functions of iodine and sulphur in the animal economy offer some interesting analogies as well as points of contrast, and have recently been reviewed by Orr and Leitch,[1] and Marston and Brailsford Robertson,[2] respectively. Our knowledge of the metabolism of these two elements, although extensive, is still incomplete at many points, but critical reviews are of value by indicating both the present position of our knowledge and also the points at which further work may be at the moment most profitably carried on. The present article will summarise briefly some of the more salient features of the positions of iodine and sulphur in nutrition and metabolism.

IODINE.

It is of interest to note that the work of the first quarter of the twentieth century has been largely a repetition of that carried out during the first half of the nineteenth, with the result that the earlier conclusions have been essentially confirmed, although the investigations were performed with few of the modern facilities for accurate research work which we now possess.

Iodine is very widely distributed in Nature, but it is usually present in only minute amounts. Even in its richest sources, such as saltpetre deposits and sponges, its maximum concentration does not exceed 0·1-0·2 per cent. In other minerals or animal tissues the amount present may be reckoned in thousandths of a milligram. It has been found in all geological deposits examined in concentrations varying from 170 γ to 9200 γ per kgm. ($\gamma = 10^{-6}$ gm.); in soils it occurs in quantities varying from 600 γ to 6000 γ per kgm.; it tends to be absorbed by acid soils and is concentrated by the plants growing on the soil, both processes leading to enrichment of the soil. On the other hand, depletion occurs in basic soils or those rich in calcium and also in heavily cropped soils. Water contains much less iodine than soil; fresh, 1 γ per litre, and salt, 17-18 γ per litre; marine plants and seaweed concentrate the iodine from sea water and form rich sources of the element. Only traces are found in salt deposits or in air.

It thus appears that plants must provide the main source of iodine for animals, and it is of importance to know something of the factors affecting the iodine content of the former. The available iodine in the soil, which may not be the same as the total iodine, is of much greater importance in determining the iodine content than the species to which the plant belongs; but the actual part of the plant in which the concentration is highest varies with the species. Sea plants contain the most iodine and land plants the least, with freshwater intermediate. The effects of supplying additional iodine for plant assimilation depend on the dosage used, the species of plant, and the medium to which it is added. In general, it may be stated that with the amount of iodine available at its optimum level, growth is at its maximum, and the iodine concentration and nitrogen assimilation are increased; the storage of useful products, for example, sugar in the sugar-beet, is improved, and there is also an increase in the aerobic respiration, and in the *p*H of the cell sap; the activity of nitrifying bacteria is stimulated. Doses greater than the optimum are toxic, but the amount required to produce such an effect varies with the species of plant studied.

In animals, the iodine content of the thyroid gland reaches 0·1-0·2 per cent or more of the dry weight, but the concentration in the other tissues of the body is much less. At present the only known function of iodine in the animal economy is in the formation of thyroxine, a stimulator of metabolism and essential for growth and health. In addition to thyroxine, the thyroid gland also contains di-iodo-tyrosine, and it appears probable that these two compounds account for the whole of the iodine content of the gland (C. R. Harington and S. S. Randall: *Chem. and Indust.*, vol. 48, p. 296; 1929). The latter is influenced by a number of factors, but depends chiefly on the intake of iodine and less upon the age, sex, or species. The differences between individuals of the same species are as wide as any differences between species, except that the glands of sea fish contain up to 1·6 per cent iodine (dry weight), whilst those of rats appear to have a low content, 0·06 per cent (dry weight) having been reported, but these differences are probably explicable by varying levels of intake. In normal glands the total iodine content increases with the age of the individual as the gland grows to its maximum in adult life, the iodine percentage remaining fairly constant; only in the very young fœtus is the percentage lower. In some animals the iodine content is greatest in autumn, coincident with an increase in the iodine content of the pasture; the percentage also varies inversely with the

[1] Medical Research Council. Special Report Series, No. 123: Iodine in Nutrition; a Review of Existing Information. By J. B. Orr and I. Leitch. Pp. 108. (London: H.M. Stationery Office, 1929.) 2*s.* 6*d.* net.

[2] Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 39: The Utilization of Sulphur by Animals, with Especial Reference to Wool Production. By H. R. Marston and T. Brailsford Robertson. Pp. 51. (Melbourne: H. J. Green, 1928.)

weight of the gland, but this is only true of normal glands.

The concentration of iodine in other tissues is low, for example, 5-15 γ per 100 c.c. of blood, rising in women at the beginning of menstruation, doubtless due to change in the physiological activity of the thyroid gland with the sexual cycle. The body tissues generally account for 40-80 per cent of the total iodine, according to the species, the remainder being in the thyroid gland.

The effects of the administration of iodine to animals are in many ways similar to those produced by feeding thyroid gland itself, since the iodine may modify the gland's secretion. Both inorganic and organic iodine occur in the blood; the former is passing to the gland or results from the disintegration of thyroxine in the cells of the body. The latter is probably chiefly thyroxine itself, on passage to the tissues of the body, since its amount is decreased after thyroidectomy. It may be pointed out here that inorganic iodine can be readily assimilated by the body, whereas inorganic sulphur cannot be utilised, only organic compounds of the latter being taken up and metabolised.

Iodine may produce increased growth in animals and in children in goitrous areas, but such a result appears to be presumptive evidence that the intake was previously below the optimum. On the other hand, thyroid administered in excess can inhibit growth, acting as a toxic agent. Small doses of iodine or thyroid increase the retention of nitrogen, whilst the larger doses of the latter increase its output; coincident with these effects, thyroid administration stimulates the general metabolic processes of the whole body, whilst small doses of iodine may, under certain conditions, decrease these, at the same time decreasing the organic iodine in the blood.

Light has been thrown on the physiology of the thyroid gland by studies of its diseases. A healthy gland stores colloid in its acini, but this only occurs where the iodine content is about 0·1 per cent of the dry weight, or 0·03 per cent of the fresh weight or more; hence an adequate intake of iodine is essential for the proper functioning of the gland. In both simple and exophthalmic goitre the percentage of iodine is subnormal. The variations in the supply of thyroxine to the tissues are reflected in alterations in the concentration of iodine in the blood.

Data from metabolism experiments and the average iodine intake in non-goitre as compared with goitre areas indicate that the minimum daily amount required for equilibrium is, in the adult, 15 γ, and in the child, 50 γ, but to allow a liberal margin of safety, at least three times these quantities should be consumed. Endemic goitre can be prevented and usually cured by supplementing the iodine intake, and it has been found that about 100 γ daily are required; this amount can be conveniently obtained by using salt to which a small dose (1 : 200,000) of potassium iodide has been added.

To sum up, animals can obtain the iodine they require from such a source as an inorganic iodide, or iodine itself may be administered; usually the requisite quantity is consumed with the animal or vegetable food eaten, partly in inorganic and also probably partly in organic form, but little is known of the organic iodine compounds in plants. In animals the iodine is taken up by the thyroid gland, for the formation of thyroxine, di-iodo-tyrosine presumably being an intermediate stage. The thyroxine has a profound influence upon the metabolism of all the cells of the body; although after its administration in even a small dose, the stimulating effect is prolonged, yet the continual loss of iodine from the body indicates that the thyroxine is continually destroyed, with the result that a steady supply of iodine is necessary to maintain a constant formation of the hormone. In the absence of a sufficient absorption of this element, the thyroid gland enlarges, and finally may fail to supply sufficient thyroxine for the needs of the body, producing a slowing of metabolism in the adult, and also, in the young, failure of growth.

Sulphur.

In contrast to iodine, animals can only utilise organic sulphur, inorganic forms being treated as waste products and excreted. Hence they are dependent upon plants or other animals for their supply of this essential element. Plants, however, can utilise sulphur and sulphates, and their addition to soils poor in sulphur increases not only the content of this element, but also the assimilation of nitrogen, indicating presumably the formation of sulphur-containing amino-acids.

Until recently, only one organic compound containing sulphur was known which is assimilable by animals, the amino-acid cystine. Natural cystine is lævo-rotatory and differs in its properties from its optical isomer and the racemic form. The cystine content of proteins, both vegetable and animal, is usually low, varying from 0·5 to 3·0 per cent, but it is still lower in gelatin and casein; wool keratin, however, contains about 13 per cent, and the protein from *Antiaris toxicaria* upwards of 25 per cent. Part of the sulphur in proteins can be split off as hydrogen sulphide by heating with alkali, suggesting that two forms of sulphur exist in the molecule, and therefore that cystine is not the only sulphur-containing amino-acid present. More recent work, however, has demonstrated that sulphur in diketo-piperazine linkage is very labile to alkali, and the two forms of sulphur disclosed by this reagent in the molecule may simply indicate cystine in diketo-piperazine and in catenary linkage respectively.

A second sulphur-containing amino-acid has been isolated from caseinogen and some other proteins in amounts of less than one-half per cent, and Barger and Coyne have recently succeeded in synthesising it and determining its constitution; it is γ-methyl thiol-α-amino-butyric acid, $CH_3 . S . CH_2 . CH_2 . CH(NH_2) . COOH$, and has been called 'methionine' (G. Barger and F. P. Coyne, *Biochem. Jour.*, vol. 22, p. 1417; 1928). The

starting-point in the synthesis was β-methylthiolpropaldehydeacetal formed from methylmercaptan and β-chloropropaldehydeacetal; from it the aldehyde was obtained and then γ-methylthiol-α-aminobutyronitrile, from which the amino-acid was easily formed.

The sulphur-containing compounds occurring in the body, for which the intake of sulphur is required, are glutathione, taurine (in taurocholic acid in the bile), chondroitin or mucoitin sulphuric acid (in mucoproteins), and sulphur-containing lipoids: whilst inorganic and ethereal sulphates occur in the urine as oxidation products of the above, with thiosulphates, thiocyanates, taurine, and cystine. In addition, oxidised sulphur is utilised for conjugation with various compounds foreign to the body tissues which might otherwise exert toxic effects.

Deficiency of cystine in the diet of a young animal is reflected in imperfect growth: thus 18 per cent of the protein phaseolin (from the kidney bean) in the diet of the young rat will not support normal growth unless 2 per cent of cystine is added. Again, adult mice will not live on diets deficient in cystine content: inorganic sulphates, sulphur, dithioglycollic and dithiopropionic acids, cysteic acid, and taurine cannot replace the cystine, but dipeptides of the amino-acid are utilised. The loss of sulphur in the urine indicates the necessity for a continuous intake of this element: mucus is also being continually lost from the body and a certain amount of taurine is excreted, although the greater part of the bile acids is reabsorbed from the gut and again excreted in the bile. Our present knowledge suggests that the necessity for a constant supply of glutathione in the cells of the body is the main factor controlling the requirement of cystine, both in maintenance and growth.

Attempts have been made to trace the paths of cystine metabolism by adding it or other sulphur compounds to the diet: by feeding compounds of cystine in which radicles have been added to the amino or sulphhydryl groups or both together, it has been shown that for oxidation to occur, it is necessary that these two groups should be free. Again, from the fact that ingested taurine is excreted unchanged, it appears that deaminisation must precede oxidation of the sulphhydryl group in normal metabolism. These processes probably occur chiefly in the liver, and the three carbon chains left after removal of the sulphur and nitrogen are either converted into protein or glucose (as in the phloridzinised dog) or oxidised completely.

The proportion of ingested cystine retained as such to that oxidised and excreted will depend on the needs of the tissues and on the form in which it is supplied. Greater retention occurs when cystine is given in a combined form, even as a dipeptide, than when administered in the free state, and it is probable that lævo-cystine is better utilised than the racemic form. In fact, the toxic influence on the kidneys of small quantities of cystine is probably due to the fact that the dextro or racemic form has been given, since larger amounts in natural combination in protein are without this effect.

The blood contains sulphur compounds on their way to and from the tissues: in man, about half the sulphur is present as sulphate, inorganic or ethereal, the other half being 'neutral' sulphur and consisting of glutathione (0·1 per cent) and ergothionine, the betaine of thiolhistidine (0·01-0·025 per cent). The physiological function of the latter compound is not known.

Taurocholic acid occurs in much higher concentration in the bile of carnivora than in that of herbivora, but during protein starvation the amount is reduced and glycocholic acid takes its place. In the dog, cystine will not increase the amount of taurocholic acid without the simultaneous administration of cholalic acid, but in the rabbit cystine alone is the limiting factor, its administration resulting in abnormally high concentrations of taurocholic acid in the bile. Free taurine is not further metabolised by the tissues, but in herbivores its administration by mouth results in an increase in the sulphate excretion, since it is decomposed by the bacteria in the large intestine.

Much work has been carried out on the detoxicating effect of oxidised sulphur compounds. The ethereal sulphate of the urine is chiefly potassium indoxyl sulphate and represents the end point of bacterial decomposition of tryptophane in the intestine: the tissues destroy the amino-acid by a different path, since it is completely burnt to its fully oxidised end products. Similarly, administered phenol is excreted in combination with sulphuric acid, but aromatic amino-acids are completely oxidised, so that phenol cannot be in their path of degradation. Certain benzene derivatives are excreted as mercapturic acids in the dog, for example, bromo- or chloro-benzene, but such synthesis probably does not occur in the pig or in man. Phenol and ortho-, meta- and parachlorphenol do not give rise to mercapturic acid formation (see T. S. Hele and co-workers: *Biochem. Jour.*, vol. 20, pp. 598 and 606; 1926: vol. 21, pp. 606, 611, and 628; 1927). When mercapturic acid formation does occur, an abundant supply of cystine is required: this is obtained by feeding the dog on a high protein diet or injecting cystine, but on a low protein diet its formation is much decreased.

Apart from the necessity for a supply of cystine for growth and maintenance, this amino-acid may have an economic importance and become the limiting factor in the suitability of a pasture for the raising of sheep for wool production, since the protein of wool contains upwards of 13 per cent cystine, whilst the food proteins probably contain only 1-2 per cent. Finally, iodine may also become the limiting factor under certain conditions, since there is evidence that thyroid feeding will improve hair growth even in under-nourished animals and at the expense of a further loss of body weight, indicating that a plentiful supply of thyroxine is necessary for hair growth as well as body growth, and that a deficient intake of iodine may decrease the production of wool even if the cystine intake is adequate.

Polyploids and Polyploidy.[1]

By C. D. DARLINGTON.

ANOTHER means of variation, closed to the ordinary diploid, is open to the polyploid. This is variation by loss. Gametes of a diploid which are not equipped with the full chromosome complement are not as a rule functional, but in a tetraploid, where every part of the hereditary material is represented twice in the gametes, loss of a chromosome or part of a chromosome does not necessarily lead to non-viability and is a possible source of a new chromosome balance, a new genetic type. This kind of change is probably responsible for a great deal of the variation in that highly variable species *Tradescantia virginiana*.

It is not surprising, therefore, that many polyploid species, both in breeding behaviour and in chromosome behaviour, resemble this second type, the type of *Primula kewensis*. The hexaploid *Prunus domestica*, having three times the chromosome number of its diploid relatives, itself usually behaves like a diploid, but when it is crossed with one of these diploid relatives the hybrid behaves like a tetraploid of the *Datura* type. Pairing takes

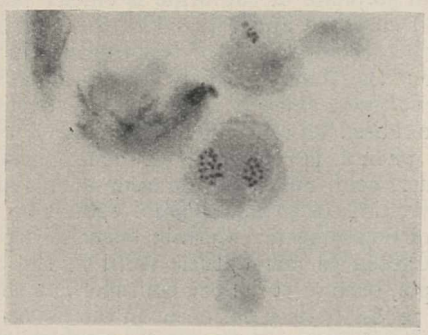


FIG. 5.—Metaphase of the second division in a pollen mother-cell of a tetraploid cherry. As a result of the formation of quadrivalents at the first division, two unequal bodies of chromosomes (13 and 19) have separated.

place not merely between corresponding chromosomes of the diploid and hexaploid, but also between corresponding chromosomes, derived each from the hexaploid, but not normally pairing. In spite of the regularity of chromosome behaviour, this analytic method of investigation is unsatisfactory from the genetical point of view, for the sets of chromosomes of the original diploid parents have probably ceased to be competent by themselves. The processes of variation found in diploids have continued in the polyploid without the same physiological restrictions. The result of splitting up the complement of a polyploid species is therefore sterility.

Hexaploid wheat or oats, when self-fertilised, breeds true in the main, but from time to time seedlings appear having the characters of related species, which have evidently remained submerged so long as the hybrid has behaved like an ordinary diploid. This segregation has been shown to follow the exceptional pairing of homologous but non-

Continued from p. 64.

identical chromosomes, presumably of specifically distinct origin. We must therefore distinguish between the *primary segregation* that results from the normal pairing in a polyploid, and the *secondary segregation* of the characters of its ultimate diploid parents, which results from the exceptional pairing of their unlike chromosomes. The behaviour in these cases is an exact parallel of that in the experimentally produced *Primula kewensis*.

When two hybrid tetraploid species such as *Triticum polonicum* and *T. durum* are crossed, complicated results are naturally to be expected from the combination of these two types of segregation. As in the *Prunus* hybrid, not two species but four are really concerned, and *a priori* we can have no reason for predicting one kind of pairing and segregation rather than another. Breeding results show that, in respect of certain chromosomes at least, there is regular pairing of the chromosomes derived from the ultimate diploid parents of each species, with the consequent segregation of their characters, and the suppression of the characters of the immediate tetraploid parents, which are never recovered in subsequent generations.

A hybrid in *Rubus* shows another complexity in segregation. Three seedlings were raised from a cross between the diploid *R. rusticanus inermis* and the tetraploid *R. thyrsiger*. Two of these were indistinguishable and, as might have been expected, closely resembled the tetraploid parent; they were triploid. The third, although obviously a hybrid, resembled the diploid parent more closely in seven well-marked characters which chiefly distinguished the two parental species. This seedling was tetraploid, and evidently the result of the union of a normal reduced male with a diploid female gamete. Thus where the female parent had made a double contribution of hereditary material, its genetical influence was increased.

This tetraploid seedling was fertile; the triploids were, as usual, sterile. In its breeding it showed two types of segregation: first a random segregation with the recovery of approximately 1 in 36 of the quadruplex recessive; secondly, the complete suppression of the characters of one parent. These results would be expected if the several chromosome types of the two species had varied independently, so that in one type there was indifferent affinity, in another a rigidly determined system of pairing. The behaviour of this cross, in both the first and second generation, affords a neat example of the application of the chromosome theory to the theory of interspecific hybridisation.

It may be worth while pointing out that, in so far as there are species in *Rubus*, this fertile seedling is a new species. Similarly, in so far as there are species in *Primula*, *P. kewensis* is a new species, and, in so far as there are species or genera in the *Cruciferæ*, the *Raphanus-Brassica* tetraploid is a new species or a new genus. Polyploidy is therefore evidently a means of species-formation. Its

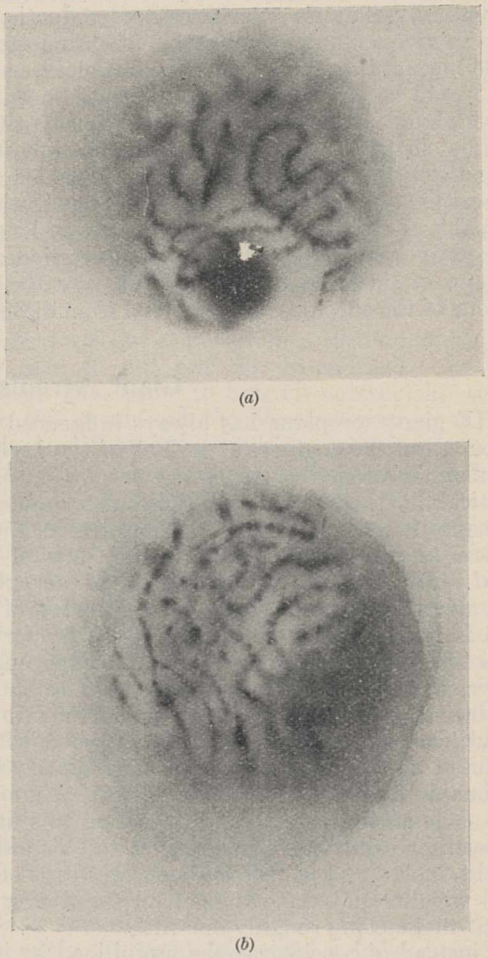
importance in evolution is more doubtful. Polyploids in their origin pass through a process that is virtually irreversible, and the advantages of their peculiar properties are therefore to a great extent meretricious. But if polyploids are not themselves of evolutionary importance the occurrence of polyploidy is probably a symptom of evolutionary processes, such as hybridisation, that are of great importance. Moreover, polyploids afford a field for the study of the hereditary material under conditions which apply critical tests of its properties. These must now be considered.

Since not merely the fertility of a polyploid but also the genetical behaviour in every other way depends on the pairing of its chromosomes, the conditions of this pairing are well worth our study. These conditions are evidently not simple, for chromosomes may regularly pair in certain circumstances (as in the diploid *Primula kewensis*), but rarely pair when identical mates are available. This problem we may shelve by saying that pairing depends on 'relative affinity'. But we may also get, as in triploid *Hyacinthus* and tetraploid *Datura*, the failure of association of chromosomes known to be identical or nearly so.

This problem, evidently related to the other, is not so easily dismissed. To understand it we must examine the processes leading up to 'metaphase' of the reduction division at which pairing is chiefly studied. At an early (prophase) stage in *Hyacinthus*, three or four threads, according to the number of corresponding chromosomes of a particular type, are seen to *pair*; that is to say, each part of each thread takes as partner a corresponding part of one of the other threads, and, furthermore, in doing so it acts independently of sections higher up and lower down the thread (see Fig. 6). We find, with three threads, one of the three is always unpaired, but it is a different one of the three that is unpaired at different points. With four threads interchanges of partner occur amongst them. Thus pairing depends not on any general affinity of the chromosomes for one another, but on the capacity of the individual parts of the chromosomes to pair. This seems equally clear from the results of genetical analysis of the forms of *Drosophila*, in which parts of chromosomes have been reversed. The basis of the affinity of chromosomes seems then to be similar arrangement of their parts. A dissimilar arrangement giving a lower affinity need not necessarily be correlated with genetic differentiation, but it nearly always will be, as it will indicate different descent.

Let us now see why these chromosomes, which probably always pair at prophase, fail to associate at metaphase. In the triploid hyacinths the failure to form a trivalent falls almost exclusively on chromosomes of a short type, and similarly with quadrivalents in the tetraploid. If the pairs formed by this type of chromosome are compared with those of the longer types, it is seen that they are relatively simple. Both kinds consist of four 'chromatids' or halves of longitudinally split chromosomes associated in pairs, but in the longer chromosomes these chromatids change partners, forming what are called 'chiasmata,' two, three, four, or five times. In the short chromosomes, on the other hand, there is rarely more than one chiasma.

The chiasmata are formed at random both as regards number and position, and with an average frequency proportional to the length of the chromosome. Only by the failure of a proportion of chromosomes to form any chiasmata at all can this normal frequency be maintained in the short type, for one of the three chromosomes must be associated with the other two and have two chiasmata.



(*a*) (*b*)

FIG. 6.—Conjugation of chromosomes in a triploid tulip. (*a*) Chromosomes lying parallel in threes before association. (*b*) Chromosomes associated in pairs with exchange of partners.

The expected proportion of failure agrees approximately with the proportion (about one-fifth) of unpaired short chromosomes found. It therefore seems probable that pairing fails merely because no chiasma is established. This implies that the relationships of the chromatids at reduction are the same as at ordinary mitosis; they are attracted in pairs. The association of the chromosomes is then the result of a failure of the pairs of chromosomes that conjugated at prophase to separate, in respect of their constituent chromatids, as they came together.

If this is generally true, then short chromosomes

newly arisen by fragmentation should fail to pair regularly, and this is so wherever it has been studied, as in *Secale*, *Zea*, and *Tradescantia*. Such variation in pairing is analogous to that found in hybrids and polyploids, for in all these types the length of the chromosome pairing at prophase is reduced as compared with that in the non-hybrid diploid. It may be reduced so that in a proportion of cases chiasma-formation, and therefore pairing, fails altogether. From the opposite point of view we may say that the mechanism of reduction is fitted to give a regular segregation of chromosomes of the normal types in a non-hybrid diploid.

It would be possible for dissimilar chromosomes to pair along a sufficient length to establish a single chiasma, in the absence of competition, but with competition in a polyploid, clearly a chiasma will be most likely to be formed between the pair which is capable of association through the greater length. Differential affinity can therefore be regarded as a measure of linear identity. In this way the behaviour of the chromosomes, derived from different species, which rarely pair in tetraploid *Primula kewensis* or hexaploid *Prunus domestica*, yet always pair in the diploid *Primula* or the tetraploid *Prunus* hybrid, is intelligible in more or less physical terms.

We have emphasised what may be called the mechanical conditions which determine the origin and variation of polyploids. This is because the physiological conditions are already widely recognised, and are not specific to polyploids, but in the study of polyploids the two types of restriction on the origin of new forms are equally evident, and it is impossible to show that one is more important than the other. Each has a final effect, and nowhere yet has any clear relation been shown between them.

This sketch of certain features of their behaviour should show that the investigation of polyploids is of importance, not merely in determining their own peculiar properties of inheritance and variation, but also in making out principles of behaviour that are equally important in the diploid organism.

Giant Aeroplanes and their Design.

THE giant aeroplane has always influenced the mind of the engineer as well as of the layman in a manner altogether out of any proportion to its practicability. Like all other structures, animal or mechanical, it is subject to the inexorable law of Nature known to engineers as the 'law of the cube'. For an established design of aeroplane with materials of unchanged quality, the law of the cube is not seriously disputed. If the proportion of useful load is plotted against surface and engine power, a well-defined family of closed isobars is obtained shrinking to a conjugate point of maximum useful load. For a braced biplane of wood with a factor of safety of 4 to 5, five tons total was a reasonable limit in pre-War days. An accumulation of detail improvements has put up this figure to seven or eight tons total weight, the disposable weight, including fuel, being about two-fifths of the total weight, and the paying load for five or six hours' flight being roughly one-fifth.

If instead of considering the useful load by itself it is considered as a fraction of the total weight, a very different conclusion is reached. The smaller the aeroplane the greater is the proportion of useful load until the indispensable weights—pilot, instruments, etc.—become a serious proportion of the total weight. A competent judge with wide experience has given the opinion that the best size from the point of view of useful ton-miles is less than two tons total weight.

The weak point in the argument is that the estimation of structural weight and aerodynamical quality is necessarily based on the best current practice, and though it is unlikely that all the competing designers in the world have missed any serious point in the theory or practice of structural design, still the possibility remains and is the standby of those who advocate the possibility and indeed the superiority of giant aeroplanes.

The history of these efforts is not encouraging. It is not necessary to refer to the positive disasters which marked the first flight of most of the early giants. Taking only recent designs, although a number of ten to fifteen ton aeroplanes and flying boats have flown and landed without accident, and have proved at least controllable in the air, yet there has not been put forward the slightest evidence that the performance as measured by useful ton-miles has increased, and much evidence that the relative performance, useful ton-miles per ton of total weight, has fallen off badly, in the very way predicted by the law of the cube.

The latest effort to break away from the natural limitation of size is that of the well-known German designer, Dornier. In a recent paper to the Royal Aeronautical Society, he announced the construction of a giant flying boat with twelve engines, distributed along the span, in pairs, with a total power of about 5000 kw. and a total flying weight of about 50 tons. It is now announced that this real giant among flying machines has successfully arisen from and alighted on the surface of Lake Constance.

The distribution of weights along the wing is an old device for reducing the stresses on the wings in steady flight. As in all other cases of design where a compromise has to be made between conflicting requirements, this is offset by a corresponding disadvantage that the stresses in a landing, especially in an unequal landing, are increased. The wing structure is thus exposed to reversed stresses of a severe and indeterminate kind. Other serious disadvantages follow.

The device has failed in previous attempts. It is advisable to wait for authenticated test evidence before accepting the truly revolutionary forecasts made by the designer, of which the most astonishing is the increase of useful ton-miles with size without limit, not merely absolutely but in proportion to total weight.

Obituary.

MR. M. R. OLDFIELD THOMAS, F.R.S.

MICHAEL ROGERS OLDFIELD THOMAS, who died in tragic circumstances on June 16 last at the age of seventy-one years, was from boyhood devoted to the study of natural history. In 1876, at the age of eighteen, he was appointed to a clerical post in the British Museum. During the two succeeding years he devoted his leisure to biological studies under Huxley at the Royal College of Science and soon proved himself to be an alert observer with most capable hands. His beautiful dissections, and the ease and speed with which he made them, soon won the admiration of his teachers; and their reports persuaded Dr. Günther, the Keeper of Zoology, to arrange for the transfer of Thomas from the clerical to the scientific staff of the Museum. Thomas used to tell an amusing story of that transfer. For some months he was aware that it was going to take place; and rumour told him that he would work in future at echinoderms. Accordingly he took up the study of echinoderms with enthusiasm. At last the great day dawned. Dr. Günther sent for him and said: "Thomas, you will do the mammals." Poor Thomas murmured something about echinoderms, but the autocrat thundered: "You *will* do the mammals." Visions of countless sheep and cattle rushed into the lad's mind and, as Thomas put it, he hated those animals from a systematic point of view for ever more.

Günther never made a wiser decision as it turned out. He was himself greatly interested in the Mammalia, and he thought that the keen, sharp-sighted boy would be just the person to help him to continue the solid contributions he was making to systematic literature on Mammalia. But the skirts of a great keeper's cloak were not ample enough to conceal for long the enthusiastic and ambitious Thomas. Günther had intended to write the Museum Catalogue of Marsupialia and Monotremata himself; but Thomas made so many discoveries and worked with such energy and painstaking thoroughness that Günther willingly relinquished the task to him. In 1888 the Catalogue was published, and it remains to this day the solid foundation of all modern systematic work on the group.

Two events which profoundly influenced Thomas's subsequent career happened in or about 1890. Before that time mammal collections consisted chiefly of spirit specimens and of specimens stuffed with their skulls inside. The Biological Survey of the United States Department of Agriculture had just been established under the leadership of Dr. C. Hart Merriam, and the first reports under the serial title "North American Fauna" were just beginning to appear. Attracted by these, Thomas found that Merriam was working with long series of carefully prepared dried skins, each skin accompanied by its own cleaned skull. Correspondence followed and Thomas decided to give the new methods a trial. In the course of the next few years he perfected them. Leaving North America in the competent hands of the Americans, Thomas resolved that the British Museum should attempt a survey of the mammals of the rest of the world—a big task for one institution with limited means and for one rather frail man to undertake.

After his marriage to Mary Kane, daughter of Sir Andrew Clark, in 1890, Thomas was in possession of considerable means. His wife, interested in natural history herself and devoted to all that concerned her husband, readily agreed to the use of as much as could be spared from their joint purse for the purpose of financing collectors of mammals in various parts of the world. They went, too, on collecting trips together into various parts of western Europe and to South America. Quickly Thomas gathered round him a band of volunteer workers in the Museum; and by hard work and perseverance he gained the ears and the purses of many wealthy people who were glad to benefit the national collections and advance the cause of science.

Gifted with an extremely practical mind, Thomas was able to cut out all unessentials; in each problem that came to him for solution he saw at once the point and the shortest way to it. He worked with amazing rapidity, jumping from one matter to another without hesitation or confusion of ideas, and he never forgot anything of importance. A continuous stream of papers flowed from his pen in the *Annals and Magazine of Natural History* from 1880 down to the present year, with many contributions to the *Proceedings of the Zoological Society* and the *Journal of the Bombay Natural History Society*. Meeting that keen naturalist the late R. C. Wroughton in 1909, they developed together the well-known Mammal Survey of India, by which huge collections of Indian mammals have been brought together and worked out, resulting in a vastly extended knowledge of this part of the zoology of India and the adjacent countries.

In all, Thomas described more than 2000 species and defined more than 200 genera of mammals. His papers are models of terse description with nothing superfluous anywhere. Indeed, over and over again he might have said a little more with advantage; but there was always another job waiting to be done and he had said enough for the present purpose. Always busy and somewhat difficult to approach, people who knew him only by his scientific writings regarded Thomas merely as a narrow systematist and a "mere museum naturalist". No greater error was ever made; he was at heart a field naturalist, and on his various journeys made important collections of flies and myriopods in addition to his mammals. But with a big task before him, he deliberately restrained his natural inclinations, saw clearly what he had to do, and lived just long enough to do it. His work has built the unrivalled national collection of mammals and the vast literature relating to it.

In order to accomplish his life's work, Thomas refused to entertain any thought of official promotion. Elected an F.R.S. in 1901, he served on the council of the Royal Society, and for many years

on the council of the Zoological Society of London. After his official retirement from the Museum in 1923, he continued his old work as though nothing had happened. The death of his wife in May 1928 was a severe blow from which he never recovered.

M. A. C. H.

PROF. HENRI ANDOYER.

BY the death on June 12 of Marie Henri Andoyer at the age of sixty-six years, French science has lost a distinguished member of that characteristic school of mathematical astronomers of which such men as Tisserand and Radau were eminent examples and Henri Poincaré the most brilliant ornament. In Andoyer a rare combination of qualities was united. To his knowledge and ability as a mathematician and his acquaintance with the technical side of practical astronomy he joined a skill and a passion for numerical calculation which recalls the kindred taste of J. C. Adams in England. He was at the same time a gifted teacher, with an enthusiasm and critical sense which made his exposition equally attractive in the shape of lectures or in published form.

Andoyer was born at Paris on Oct. 1, 1862, and entered the École Normale Supérieure in 1881, devoting himself to the study of pure mathematics. The years 1885–92 were spent at Toulouse, where Andoyer was attached to the Observatory but more actively engaged as professor in the faculty of science. As astronomer, however, he took part in organising the work of the Astrographic Chart, and attended the early conferences on the scheme at Paris. In 1892, before this work had advanced beyond the preliminary stages at Toulouse, Andoyer was recalled to Paris to deliver a course of lectures on mathematical astronomy and celestial mechanics and to share in the teaching of mathematics in the Faculty of Science. To this period belongs his "Leçons sur la théorie des formes et la géometrie analytique supérieure", together with a number of more elementary text-books and some original papers, all devoted to pure mathematics. It was thus comparatively late in life that his devotion to mathematical astronomy asserted itself as an absorbing study, and even after 1903, when he was appointed professor of astronomy at the Sorbonne, his interests were not always confined in any narrow sense to the subject of his chair. The germ to be seen so early as 1887 in a paper on intermediary orbits, inspired by the work of Gyldèn, was a little slow in bearing fruit.

In 1910, Andoyer succeeded Bouquet de la Grye as a member of the Bureau des Longitudes, and on the death of Radau in the closing days of 1911 followed him as editor of the *Connaissance des Temps*. The annual ephemeris has appeared under his direction from the year 1914 onwards, and has fully maintained the high reputation earned for it under his predecessors.

Two works of permanent value embody the substance of Andoyer's teaching. One, "Cours d'astronomie", comprises a first volume on theoretical astronomy, which reached its third edition in 1923, and a second on practical astronomy, of which the second edition, in collaboration with A. Lambert, appeared in 1924. The other, "Cours de mécanique céleste", in which stress is laid on the computational side of this intricate subject, was published in two volumes (1923 and 1926).

The theory of the moon's motion, after the work of Delaunay and Radau on one hand, and of Hill and E. W. Brown on the other, presents a field offering little scope for easy or striking achievements of a novel kind. But it was to this difficult and in appearance fully explored problem that Andoyer turned repeatedly with complete knowledge of what had been done by others. It is the subject of his last considerable work, "Sur la théorie analytique du mouvement de la lune", the culmination of a series of critical studies in a branch of astronomy for which he was exceptionally qualified by natural gifts.

Andoyer's passion for numerical calculation found scope in the recomputation of fundamental logarithmic and trigonometrical tables. Executed single-handed and with remarkable rapidity, equal evidence of unfailing industry and quite extraordinary skill, these tables were published between 1911 and 1918. It is likely that they will not be superseded by any later work of the same kind, at any rate performed in the same fashion.

Andoyer was elected an associate of the Royal Astronomical Society in 1914 and became a member of the Paris Academy of Sciences in 1919. He was Officier of the Legion of Honour. Of a modest and simple disposition, he will be mourned by a circle of colleagues, and his death removes from the ranks of astronomy a gifted and indefatigable worker not easily replaced.

H. C. P.

WE regret to announce the following deaths:

Mr. W. S. Andrews, at one time associated with Edison in electrical developments and distinguished for his work on fluorescence and phosphorescence and selenium cells, on July 1, aged eighty-one years.

Dr. Charles F. Brush, of Cleveland, Ohio, the inventor of the electric arc light known by his name, on June 15, aged eighty years.

Prof. Wilhelm Ellenberger, formerly rector and director of the physiological and histological institute and of the physiological chemistry research station of the Veterinary Highschool, Dresden.

Lieut.-Colonel George Henderson, formerly of the Indian Medical Service and for a time Director of the Royal Botanical Gardens and professor of botany in the University of Calcutta, on June 24, aged ninety-two years.

Major C. V. Hodgson, hydrographic and geodetic engineer and assistant chief of the division of geodesy, U.S. Coast and Geodetic Survey, who had taken part in many surveying expeditions to the waters of Alaska and the Philippine Islands, and was known chiefly for his work on geodetic astronomy, on May 19, aged forty-nine years.

Mr. G. R. Kaye, formerly of the Indian Education Department, author of some well-known works on Indian astronomy.

M. Léon Lindet, member of the Section of Rural Economy of the Paris Academy of Sciences, known for his work on the physiology of plant and animal foodstuffs, on June 16, aged seventy-two years.

News and Views.

WE have referred from time to time in these columns to the importance of scientific research in the development of the British Empire overseas and to the work in this connexion of Mr. L. S. Amery and Mr. W. Ormsby-Gore, Secretary and Under-Secretary of State for the Colonies respectively in the recent Conservative Government. That there is to be continuity of effort and to some extent of policy by the present Government appears probable from the speech made by Mr. J. H. Thomas in the House of Commons on July 12 last, in moving a resolution, which was agreed to, "authorising the Treasury, on the recommendation of a Committee to be appointed by the Secretary of State, to make advances, either by way of grant or by way of loan, to the Governments of certain Colonies, territories under his Majesty's protection, and mandated territories, for the purpose of aiding and developing agriculture and industry in the Colonies or territories and thereby promoting commerce with or industry in the United Kingdom". The resolution authorises the annual payment of not more than one million pounds, and Mr. Thomas has in mind a small but active committee to allocate the grants. An unexpended residue in any year will not be available in the succeeding year. Mr. Thomas thinks that speeding up colonial development will provide much useful work in Great Britain; indeed, the scheme is part of his plan for dealing with unemployment generally.

IN the discussion of Mr. Thomas's resolution, Mr. Amery specifically raised the question of scientific research, health campaigns, etc., and obtained an assurance from Mr. Thomas that nothing which could be called 'development' would be excluded. Mr. Ormsby-Gore also referred to this question, and stated that research undertaken under this resolution should be in relation to purely local problems or those affecting a group of colonies only and, as such, outside the purview of the Empire Marketing Board. Mr. Thomas stated that the risk of overlapping the work of the Empire Marketing Board has been foreseen, but he does not anticipate difficulty from this cause. Much was said during the debate about industrial development and little about scientific research, which is its necessary antecedent. Mr. Thomas has promised a small committee of "knowledge and experience". Obviously, the successful working of the scheme will depend almost entirely on the composition of this committee; we trust, therefore, that some members at least will have "knowledge and experience" of the prime necessity of scientific research in the development of tropical countries.

A LECTURE with demonstrations was given by Sir J. C. Bose on July 9 at the India Office, the Right Hon. Wedgwood Benn, Secretary of State for India, being in the chair. Sir J. C. Bose thinks that the mechanism of life can best be studied in the more fundamental and earlier form presented in plants. This can only be realised by exceeding the range of perception of our organs of sensation by means, for example, of his 'contraction recorder' which, it was stated, produces a magnification of fifty million times. Great as this is, it may be mentioned that, even before the advent of the thermionic valve, the combination of optical and electrical methods had exceeded this magnification and that optical methods of recording exhibit superiority over mechanical means from the point of view of freedom from inertia, time-lag, and speed as well as magnification. An experiment was performed which included the chairman and the stem of a lupin plant in series with the secondary of a small induction coil; the interrupted primary current was gradually increased and the plant stem was found to bend before the human subject objected to the strength of the electrical stimulus. This does not necessarily show, however, that the plant was more sensitive than the human being; whereas the plant early exhibited locally unequal degrees of mechanical contraction as a result of electrolytic changes at the site of passage of an electric current, the human being experienced a sensation which, in the usually accepted terminology, involves a change in consciousness. A valve voltmeter or a thermo-vacuo junction included in the same circuit would have proved more 'sensitive' than either plant or animal.

IT is perhaps well to make it quite clear that the term sensitivity has quite a different connotation in physiology from that which it has in physics; it would thus appear that the so-called sensitivity of plants, for example, to light, gravity, and electrical, mechanical, and chemical stimuli, is of the purely physical type and must obviously remain so as long as we regard consciousness as the discriminating attribute between animal and plant. Other experiments of Sir J. C. Bose have led him to assign to plants nervous and cardio-vascular systems. One such experiment was demonstrated: the stem of a drooping lupin leaf was placed in a tube of water and camphor was added to the latter. The erection of the leaf in a jerky manner (responding just like a crinkled balloon to steady inflation) was presumed as evidence of the existence of a pulsatile organ in the plant causing the ascent of sap. A consideration of the purely physical action of camphor, for example, on surface tension would merit attention in this connexion. Seeing Sir J. C. Bose's demonstrations, it is impossible to question the occurrence of the phenomena he describes; but animal physiologists will not readily accept his interpretations. Sir J. C. Bose also showed pictures of the Bose Research Institute at Calcutta. It is to the co-operation of workers trained in this and similar institutes with the intellect of Britain that Sir J. C. Bose looks for the solution of the common difficulties of the two nations.

THE Devonport Pathological Laboratories of the Seamen's Hospital, Greenwich, together with a new Nurses' Home, were opened by their Royal Highnesses the Duke and Duchess of York on July 15. The

laboratory building is constructed of sand-faced red brick and stone from designs by Sir Edwin Cooper, the cost being defrayed out of a fund collected by Lord Devonport. The laboratories on two floors are placed around a central entrance hall and staircase. The lower floor accommodates two staff laboratories, a large preparation room fitted with boilers, hot-air and steam sterilisers, autoclave and serum inspissator, and the office, and at either end a large room is allocated as museum and library respectively. An animal house and a workshop are located in a short southern wing, and mortuary (with cold storage), post-mortem room, and class-room for operative surgery in a corresponding northern wing. The upper floor accommodates two staff laboratories with rooms for assistants, a biochemical laboratory with balance and dark rooms attached, and several smaller rooms for research workers. The flooring throughout is of wood block, except in the entrance hall; the working benches are of teak, and are supplied with water, gas, and electric current (light and power), and internal and Post Office telephones are installed in each laboratory. The equipment of centrifuges, incubators, microscopes, microtomes, and glass apparatus is very complete. Heating is by hot-water radiators supplied from the boiler-house near by, in which is also a gas incinerator for destruction of waste and infective materials.

IT is reported in the *Times* of July 15 that a charter for the constitution of trustees to administer the National Radium Fund and to provide for the duties of the National Radium Commission, has been granted by the Privy Council. The charter makes provision for the election of trustees of the radium and for an executive body to be known as the National Radium Commission. The trustees will hold all the moneys and buy therewith and hold radium for use by this Commission. The duties of the Commission will be to deal with the distribution and use of all radium held by the trustees, having regard to the advancement of knowledge and economy of use; and to approve plans for the use of radium for medical treatment and research. It is thus seen that the duties of the Commission are wide ones and the granting of this charter marks a very important phase in the development of radiology in Great Britain.

UNDER the auspices of the Beaux Arts of France, and with the concession granted by the French Republic to dig at Combe-Capelle in a remarkable Moustierian site, Dordogne District, the Canadian School of Prehistory has just opened its season for 1929, headquarters being at the classic site of Les Eyzies de Tayac. The season of 1928 proved so fruitful in results that the School was enabled to install in several museums of the universities of Canada collections illustrating the activities and industries of early man from the Ipswichian (pre-Chellean) to the Robenhausian Period. Of the problems remaining to be solved in the Moustierian Period, the Canadian School was fortunate enough to obtain evidence in four distinct zones below the "Vieux Moustierien" of the classic section of Le Moustier, which add new information to the facts already known with respect to Moustierian man (Neanderthal). After careful inspection of all the collections made by the Canadian School in France by the Administrator of the Beaux Arts in the Dordogne District (M. Peyrony), the Laboratory of Geology and Palæontology at Ottawa, the School's headquarters in Canada, was further replenished with about 8000 specimens for distribution.

THE School in 1928 visited many of the sites of the Dordogne, Charente, and Pyrenees sections of France, under the guidance of M. Peyrony, Count Begouen, Dr. Henri Martin, Abbé Breuil, and others. By special invitation to visit and explore the Neolithic site of Ryckholt (Ste. Gertrude) in the highlands of Holland, the Canadian School was able to add an excellent series of specimens to its collections for Canadian universities. A movement is now on foot in Canada to incorporate by Act of Parliament the Canadian School of Prehistory, with the object of backing up the work that has been done and is being done by the School in France. The movement is led by Dr. E. R. Cameron, K.C., of the Supreme Court, and a number of leading archæologists and ethnologists of the Dominion. One of its chief objects will be the investigation of prehistoric sites in the northern districts of Canada where the Eskimos and the reindeer, with the musk-oxen, great stag, and bisons, are found to-day, all well-known types of life which once lived in south-western France in Magdalenian times. The Canadian School welcomes visitors to the site at Combe-Capelle where the excavations are going on, and especially those from the British Isles and other parts of the Empire interested in prehistory.

THERE is a demand for radio telephone sets by owners who can pilot their own aeroplanes. The sets used by commercial aircraft are much too heavy for light aeroplanes. The transmitter must have a range of at least fifty miles when communicating with the ordinary aerodrome ground station and a hundred miles when communicating with a large station like the one at Croydon. The Marconi Co. has now designed a set to meet these requirements. It combines a telephone transmitter and receiver in a compact wooden box the dimensions of which are only 16 in. by 9 in. by 7 in. Its weight, including that of the wind-driven generator, accumulator, aerial and connecting leads, is only 60 lb. The set has been designed for the transmission of telephony only. Pilots have quite enough to do in flying their machines and watching their instruments without the added labour of interpreting telegraph signals in the Morse code. The set may be installed for operation by the passenger or it may be fitted in any convenient part of the aeroplane and operated by the pilot through a 'remote control'. In the latter case there is only a one-handle manipulation. Seeing that private air cruising on business and pleasure is rapidly becoming popular, we welcome this device. Advice regarding the state of the weather and the conditions at the various aerodromes will now be available to light aeroplane tourists. In addition, they will now have a valuable means of position finding when flying over parts of the Continent and other places where there are aerodrome

ground stations fitted with direction finders. We hope that the international regulations enforcing adequate radio facilities on commercial aircraft will now be enforced on privately owned aeroplanes.

IN August next the *Discovery* will set out once again on a voyage of exploration and scientific discovery to the Antarctic continent. The enterprise, which is under the leadership of Sir Douglas Mawson, is being sponsored by the British, Australian, and New Zealand Governments, and considerable assistance in money and kind has been given by private individuals and firms, both in England and Australia. Mr. MacRobertson, a wealthy manufacturer in Melbourne, has contributed £10,000 to the funds of the Expedition, and several other private subscribers are assisting, but no general appeal to the public is being made for funds. The *Discovery* is now being overhauled at the West India Docks, and is being fitted with all the essential scientific gear that the forthcoming expedition makes necessary. Capt. J. K. Davis, who has been lent by the Government of the Commonwealth of Australia, has been appointed master, and will also act as second in command of the expedition. He was associated with Sir Douglas Mawson in a similar capacity on the pre-War Australasian Antarctic Expedition and has special and extensive experience in the Antarctic coastal and pack-ice waters. The scientific personnel and crew will number about forty. The vessel will carry an aeroplane with floats for rising from and alighting on the sea (where open water makes this possible), and alternatively will use a ski undercarriage for use on ice or snow. The aeroplane will be used for scouting, for photographing the coast-line, and for general purposes as a 'long arm' of the expedition. The ship will be equipped with powerful deep trawling gear and with echo-sounding apparatus. Both long-wave and short-wave wireless equipment will be carried. The expedition will carry out hydrographic survey work, and will study meteorological conditions with the view of discovering any relationship between those conditions and the climate and weather of Australia. It will also carry out investigations of the fauna, notably whales and seals, of the region explored.

DR. WILLIAM HUME-ROTHERY has been elected to the research fellowship in metallurgy of the Armourers and Brasiers' Company in succession to Dr. Constance F. Tipper.

THE Autumn Lecture of the Institute of Metals will be delivered during the forthcoming Düsseldorf meeting on Sept. 5 by Mr. A. G. C. Gwyer, who will speak in German on aluminium and its alloys.

THE following appointments have recently been made to the Imperial Bureau of Soil Science: Scientific assistant, Mr. A. J. Lloyd Lawrence; assistant for translations, Miss H. Sherbatoff.

MR. H. T. TIZARD, permanent secretary of the Department of Scientific and Industrial Research, has been appointed rector of the Imperial College of Science and Technology as from the beginning of September in succession to Sir Thomas Holland.

WE learn from Miss C. J. Vivian, 4 Dolcoath Road, Camborne, Cornwall, that a vigorous tremor was experienced at about 7 P.M. on July 7 in various parts of Camborne. In a church at Penponds, near Camborne, the vibration was so intense that the rafters creaked audibly. Old tin-mine workings undermine a part of the town, but a subsidence of the soil due to this could scarcely cover the district affected.

THE following have been elected officers for the session 1929–30 of the British Institute of Radiology incorporated with the Röntgen Society—*President:* Mr. C. Thurstan Holland; *Past Presidents:* Sir Humphry Rolleston and Dr. G. W. C. Kaye; *Vice-presidents:* Sir William Bragg, Mr. L. A. Rowden, and Major C. E. S. Phillips; *Honorary Treasurer:* Mr. D. B. McGrigor; *Honorary Secretaries:* Dr. Stanley Melville and Dr. G. Shearer; *Honorary Editors:* Dr. G. W. C. Kaye and Mr. R. J. Reynolds.

THE annual report and accounts for 1928 of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, S.W.15, has been issued. The Institute was founded primarily to carry out research work in the prevention and treatment of tropical diseases, and is supported entirely by voluntary contributions. An account is given of the visit of Sir Malcolm Watson and Major Stevens to India and Ceylon for the purpose of advisory and propaganda work on malaria, and of the research work carried out in the Institute.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A head of the Engineering Department of the Leicester College of Technology—The Registrar, College of Technology, Leicester (July 22). An assistant county agricultural organiser under the Hampshire Agricultural Education Committee—The Agricultural Organiser, 82 High Street, Winchester (July 24). A head of the Mechanical Engineering Department of Robert Gordon's College, Aberdeen—The Secretary and Registrar, Robert Gordon's College, Aberdeen (July 29). An assistant lecturer in physics in the University of Leeds—The Registrar, The University, Leeds (July 29). A lecturer in pharmacy in the Department of Chemistry of the Witwatersrand Technical Institute—Messrs. Chalmers and Guthrie, Ltd., 9 Idol Lane, E.C.3 (July 31). An assistant lecturer in the Department of Chemistry of the University of Birmingham—The Secretary, The University of Birmingham (July 31). A superintendent of the Burma Civil Veterinary Department—Secretary to the High Commissioner for India (General Department), 42 Grosvenor Gardens, S.W.1 (Aug. 4). A lecturer in physiology in the University of Birmingham—The Secretary, The University, Birmingham (Aug. 5). A demonstrator in civil and mechanical engineering in the Department of Engineering of the University of Leeds—The Registrar, The University, Leeds (Aug. 5). Two timber assistants for the Utilization Forest Circle, Commercial Concern, Burma—The Secretary to the

High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Aug. 10). A lecturer in mineralogy and petrology in the University of Reading—The Vice-Chancellor, The University, Reading (Aug. 14). An assistant plant pathologist under the Department of Agriculture and Forests of the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (Aug. 15). An assistant superintendent in the Archæological Survey Department of the Government of India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (Aug. 17). A professor of geology and mineralogy in Rhodes University College, Grahamstown—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (Aug. 31). A research assistant in the Colour Chemistry and Dyeing Department of the University of Leeds—The Registrar, The University, Leeds (Sept. 2). A professor of clinical pathology in the Egyptian University, Cairo—The Dean, Faculty of Medicine, Egyptian University, Cairo (Sept. 15). An assistantship in natural history—The Secretary, University College, Galway (Sept. 21). An assistant director of the Technological Library of the Indian Central Cotton Committee, Bombay—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Sept. 29). Part-time lecturers in market research and sales management at the Polytechnic, Regent Street—The Director of Education, The Polytechnic, Regent Street, W.1. A head of the pathological division of the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee, Rubber Research Institute of Malaya, 2-4 Idol Lane, Eastcheap, E.C.3. A lecturer in mathematics at the Gordon College, Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. A full-time chief instructor of the Printing Department of the North-Western Polytechnic, Prince of Wales Road, Kentish Town—The Secretary, North-Western Polytechnic, Prince of Wales Road, N.W.5. An assistant master to teach mathematics in the Junior Technical School for Boys of the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18. A teacher of telephony in evening classes at the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18. A chief officer for the Imperial Agricultural Bureau for Plant Genetics: Herbage Plants—Prof. R. G. Stapledon, Agricultural Buildings, Aberystwyth.

Our Astronomical Column.

July and August Meteors.—Mr. W. F. Denning writes: "The season for meteoric abundance has now opened and a large number of showers are visible, including the early phase of the great Perseid display. The latter appears to be visible during the whole of July and August with a maximum on Aug. 11 or 12. Probably the morning of the latter is the period when most meteors will be visible. The present year seems likely to be favourable for the occurrence of many meteors, for an abundant maximum of 250 per hour for one observer was counted in 1921 on the early morning of Aug. 12. The earth will occupy very nearly the same position in its orbit on the morning of Aug. 12 next, and the shower may be repeated if the density of the part of the stream encountered is about equal to that through which the earth passed eight years ago. This may be doubted, however, though there are slight evidences of an eight-year period in the character of the display and observations may prove specially interesting. The Capricornids (July 19–Aug. 6) with radiant at 304° – 11°, and the Aquarids (July 24–31) radiant 338° – 11°, usually form two of the principal displays of the July–August period; but there are some hundreds of others exhibiting various degrees of strength, though the majority are very attenuated and are only to be recognised by long and accurate observation."

Ancient Greek Astronomy.—M. E. M. Antoniadi contributes an article to *L'Astronomie* for May in which he points out that several of the philosophers of ancient Greece anticipated the conception of universal gravitation. Anaxagoras, Plato, Aristotle, and others perceived that massive bodies exercised a force directed towards their centres. Aristotle ascribed the tides to the action of the sun. Anaxagoras and Empedocles recognised that the centrifugal tendency of a revolving body, such as the moon, enabled it to circulate round a central orb without falling into it. While these conceptions were quite sound, it does not appear that they were tested numerically with the same rigour as was done by more modern philosophers. Newton deduced from Kepler's laws that the sun exerts an attractive force on the planets varying as the inverse square of the distance. He did not announce his law of universal gravitation, however, until he had demonstrated that the fall of the moon towards the earth in a second was to the fall of a body at the earth's surface in the ratio of inverse squares of the distance from the earth's centre. He also demonstrated that a sphere attracts external bodies as though concentrated at its centre. Hence while we recognise the merits of the ancient philosophers, we cannot put them on the same level as Newton.

Measures of the Brightness of Earth-shine.—Prof. H. N. Russell in the *Scientific American* for July gives an account of the measures of the intensity of earth-shine on the moon made by M. Danjon at Strasbourg. He used an ingenious photometer of his own design in which the light of the sunlit lunar crescent was admitted to one section of the objective, weakened by reflection from plane unsilvered glass surfaces, and then compared with the earth-shine admitted into another section of the objective. He found that when the moon is 30° from the sun the earth-shine is $\frac{1}{1000}$ of the intensity of an equal portion of the sunlit crescent; at 90° from the sun the ratio is less than $\frac{1}{10000}$; at 120° from the sun it is $\frac{1}{40000}$. It cannot be followed further than this. The experiments also showed that the earth-shine was bluer than the reflected sunlight; they indicated that the earth is a less rough reflector than the moon, which is reasonable since much of the earth's light would be that reflected from vapours in its atmosphere. The resulting albedo of the earth is about 29, perfect whiteness being represented by 100. The figure is lower than previous estimates, which have been in the neighbourhood of 50. It is concluded that the full earth would give the moon $\frac{1}{10000}$ of the light of the sun, or more than 40 times as much as the full moon gives us. Allowing for the difference of areas, the albedo of the moon is $\frac{1}{3}$ of that of the earth, or about 10.

Research Items.

The Spirit Cult in Hayti.—The spirit cult of Hayti, more popularly known as 'voodoo', is the subject of a communication by Dr. Elsie Clews Parsons in the *Journal de la Société des Américanistes de Paris*, N.S. t. 20. The spirit cult has hitherto been undescribed, owing to the attention given to one of its reputed features, namely, ritual cannibalism, the folklore of which is widespread among foreigners. If human sacrifices occur or have occurred, it is in connexion with the 'taureau criminel', the criminal bull, one of the *loi* or spirits, of which there are a large number, both Catholic and African. The cult makes no distinction between patron saint and West Coast fetish, and may be described as the theory and practice of possession by spirits. Every *loi* has his or her traits, an appetite for this or that offering; some like *tafia* (rum), others lean to a taste in dress or colour, a particular day of the week, a particular way of taking possession, and so forth. For example, *Loi Gédé* talks through his nose when he takes possession of anyone; he eats only cassaba, pepper and herring; he is a master of the cemetery. *Loi Exili* likes handkerchiefs and nice clothes; they must be red; in her food perfume must be put, and her favours are for men only, and nothing for girls; she is identified with a Catholic saint who carres a dagger in the hand. People who get *Loi Coulève* (snake spirit) walk on their bellies. The snake is small in the day-time but at night it becomes so big as to weigh down the branches of trees. It visits houses, and people do not kill it. The *loi* may be cherished by anyone and may take possession of anyone, or it may have been inherited within the family so far back as the old people who were born in Guinea. Maintaining the shrine of the *loi* or making proper food offerings are important ways of holding their favour. The ceremonial cult of the spirit is observed in *Mangé loi* and *dansé loi*, spirit feasts and spirit dances, in which some, or at times all, participants are possessed. Secrecy attaches to them to a greater or less degree according to the disposition of the local constabulary.

Way-finding of Birds.—The factors concerned in the migration of birds appear to be manifold and not easily disentangled, but it is generally held that the impulse to migration is associated with the development of the sex organs. One of the most extraordinary facts of annual bird movements, conclusively proved by the method of ringing, is the return of spring migrants to the locality and even to the exact place in which they were born, and the question arises whether this orientation is connected in any way with the development of the sex glands. A problem, allied but not identical, has been tested by G. J. van Oordt and C. J. A. C. Bol (*Biolog. Centralbl.*, Bd. 49, 1929, p. 173). Carrier-pigeons possess an exceptionally strong 'bump of locality', and if this power is associated with the sex glands, the influence of castration should be apparent. The result was negative: the only conclusion to be drawn from the experiments was that the sex hormones had no influence whatever on the way-finding of carrier-pigeons. This result has, of course, no bearing upon the origin, the significance, or the purpose of bird orientation, but it must be regarded as a caution against premature acceptance of the suggestion that sex-hormones play a part in the direction impulse of wild migratory birds.

Aquatic Caterpillars.—H. S. Pruthi (*Records Indian Mus.*, vol. 30, pt. 3, 1928) describes the aquatic larva and pupa of *Aulacodes peribocalis*. He observed the caterpillars in the Nerbudda river in November-December 1927 wherever the water was shallow and the current rapid. They spin their silky shelters, irregular in outline, in the crevices of rough stones. The shelter, which lodges only one caterpillar, is loosely attached to the substratum, leaving numerous openings by which water can enter or leave it, so that there is a free circulation of water round the caterpillar. The caterpillar does not appear normally to leave its shelter, and there seems to be no reason why it should, for there is always around it, within the shelter, an ample supply of fresh water laden with food materials—the larva probably feeds on minute pieces of alga. Its mouth-parts are like those of terrestrial caterpillars. Although the caterpillar is aquatic it cannot swim; if its shelter is torn away the caterpillar creeps towards the under sides of stones. The caterpillar is provided with eleven pairs of well-developed gills borne by the second and third thoracic and the nine abdominal segments, but it can live for four days after being taken out of the water. Spiracles are present, but their openings appear to be closed and the lumen of the tracheæ connecting them to the lateral tracheal trunks is more or less obliterated. When the larva is full grown, it makes under its shelter a tough and complex dome-shaped cocoon in which the pupal stage is passed. The central cavity of the cocoon communicates with the exterior by a very narrow crescent-shaped slit towards which the head of the pupa points. The moth emerges through this opening.

Brooks's Law.—Robert Gurney (*Internat. Rev. d. ges. Hydrobiol.*, Bd. 21, 1928) has examined a number of growth stages of Copepoda with the view of testing the validity of 'Brooks's Law' propounded by Fowler (1909) as follows—"during early growth, each stage increases at each moult by a fixed percentage of its length which is approximately constant for the species and sex". Both Fowler, working on marine Ostracoda, and Sewell, on the Copepoda of the Bay of Bengal, found that in some cases there were two adult forms in each sex distinguished by size, and in one case the two forms of the adult male differed also in some structural features so much that they would have been admitted as distinct species if they had been taken separately. The author has investigated fresh-water plankton, in which as a rule only one species of Calanoid occurs, as being more favourable material than marine plankton containing a number of species. He gives details of growth factors in half a dozen species, and his general conclusion is that 'Brooks's Law' as stated by Fowler cannot be upheld but that the subject is worthy of more attention. Within rather wide limits there probably is a specific growth factor, but there is much individual variation, and the factor changes from moult to moult in most cases. The presence at the same time of large and small forms of the adult, according to the view of Fowler and Sewell an example of dimorphism within a single race, is capable of other explanations. The author finds it difficult to escape any other explanation than that there is a moult in a small proportion of the adults.

Control of the Codling Moth.—We learn from a recent *Daily Science News Bulletin* issued by Science Service, Washington, D.C., that an experiment is under way to attempt the control of the codling moth in the walnut groves of California by biological means. Advantage is being taken of the fecundity of a minute chalcid egg-parasite by adopting mass-rearing and liberation of the latter. The parasite

(*Trichogramma minutum*) is known to attack a great variety of insect eggs, and those of the grain moth have proved well suited for the experiment. It is stated that, in a building with a floor space of only 25 ft. × 36 ft., it is now possible to rear one million *Trichogramma* per day, the whole technique being a matter of skilful standardised routine. Packages containing 100,000 parasitised eggs of the grain moth occupy a very small space, and are easily sent by mail to growers troubled with codling moth. The parasites which emerge from these eggs are liberated in the walnut groves, and soon commence seeking out codling moth eggs, which are at hand in abundance. It is hoped that by materially raising the *Trichogramma* population in given districts, wholesale destruction of codling moth eggs will result, with a consequent reduction of the injuries wrought by this insect.

Light Periodicity and Plant Growth.—A further study of the importance of light duration as a factor in plant growth has been made by G. Reddington (*Trans. Roy. Soc. Edin.*, **56**, 247-272; 1929), using throughout specified conditions of electric lighting. A large number of species of plants were examined and all, except beech seedlings, grew *initially* best in continuous light but *finally* best in 16 or 8 hours of light per day. The results are explained on the supposition that carbohydrate supply is primarily the limiting factor in growth, but that, where continuous light is used, water strain may, in the later stages, limit food and water supply to the growing points. Detailed observations are given in support of this argument.

Movements of Liquids and Gases in Trees.—The problem of the ascent of water in trees is being re-examined by D. T. MacDougall, J. B. Overton, and G. M. Smith, and they have recently reported (*Carnegie Instit. Wash.*, No. 397; 1929) data as to the movements of water and gases in various trees. They find great differences in the paths of movement of dye solutions injected or allowed to enter into woody stems. In some species these only move along the summer wood, in some only along the spring wood, and in others along the late autumn and early spring wood. In Monterey pine, however, the dye travels along the whole of each annual ring of wood. The evidence suggests that the non-conducting vessels are full of gas. Examination of the internal gas pressures shows them to be subject to considerable seasonal variations. Applying suction to the gas in the tree increases the tensions on adjacent water-filled manometers, but if gas pressures (of 4 atmospheres) are applied, they are registered by air manometers 2 m.-3 m. higher up the tree but not by water-filled manometers. It is therefore concluded that varying internal gas pressures have little effect on the cohesive water system.

Miocene Mollusca of Virginia and North Carolina.—Mr. W. C. Mansfield in a short paper (*Proc. U.S. Nat. Mus.*, vol. 74, art. 14) briefly outlines the different divisions of the Chesapeake group of the Miocene epoch in Virginia, and describes and illustrates on wonderfully clear plates, seven new species and five new sub-species of mollusca therefrom. We are promised further and more complete discussion of the whole in a forthcoming number of the George Washington University *Bulletin*.

Height of Mount Everest.—A note on this subject appears in the General Report of the Survey of India for 1927–28. The value of 29,002 ft. was computed in 1852 from observations taken in 1849–50. The last figure is retained, not on account of its probable accuracy, but in order to avoid the suggestion of an estimate in round figures. In 1907, Sir Sidney Burrard calculated the height to be 29,141 ft. Dr. de Graaff Hunter, applying improved refraction corrections to results from different observation stations, gets a height of 29,149 ft., which has a probable error of less than 5 ft. and a possible error of less than 15 ft. This, however, is more than the true geoidal height. When the correction is applied, Mount Everest has a probable height of 29,075 ft., with a possible correction of 25 ft. either way. It is impossible at present to give the height of Mount Everest with greater accuracy.

The Upper Atmosphere.—In the issue of the *Physikalische Zeitschrift* for Mar. 1, Prof. H. Benndorf, of the University of Graz, gives an account of the methods which have been used recently to obtain a more precise knowledge of the properties of the upper atmosphere. Altitudes of 20 km. to 30 km. have been attained by pilot balloons with registering instruments, but for greater altitudes the study of the propagation of sound waves through the atmosphere has given the most trustworthy data. Prof. Benndorf considers our present knowledge justifies the following statements. Traces of atmospheric gases can be detected at altitudes of 1000 kilometres, and at such altitudes motions of these gases must be rapidly damped down owing to their high kinematical viscosity. In the northern hemisphere there is a drift of the layers between 30 km. and 80 km. altitude to the east and above that to the west. In the 'troposphere' up to 12 kilometres convection currents keep the atmosphere well mixed and the temperature decreases with altitude until 220° absolute is reached. In the 'stratosphere' above, convection is less marked and the temperature remains constant at 220° up to 30 kilometres. Between 40 km. and 60 km. a layer at about 300° absolute—a tropical temperature—exists. For greater heights no statement can be made, nor is the composition there known, but there is no doubt that the gases there are ionised, that the negative ions are electrons, and that at altitudes of 80 km. to 100 km. there exists at least one conducting layer with free electrons numbering 10^5 per c.c.

An Optical Law for Electrons.—The existence of still another analogy between electrons and waves has been indicated by E. Rupp in a recent issue (May 17) of *Die Naturwissenschaften*. When slow electrons impinge on a very thin sheet of metal, those which are not retarded are transmitted selectively, silver, for example, being very approximately two and a half times as opaque to electrons with an energy equivalent to 11 volts as it is to 16-volt electrons or 8-volt electrons. It is now found that the same selectivity is exhibited in reflection of electrons without loss of energy, silver again reflecting electrons particularly well when their energy is close to 11 electron-volts, and it would thus appear that the optical law connecting absorption and reflection is valid for electron waves. No relation has yet been traced between the wave-lengths of the electrons and the atomic constants of the metal foils, but it is suggested that absorption and reflection of the slow electrons are occasioned by the outer dispersion electrons of the metallic atoms.

Melting-point of Palladium.—A determination of the melting-point of palladium by Hoffman and Meissner in 1919 resulted in a value of 1556° C.,

which is 3° above the previously accepted temperature, and it is therefore interesting to note that a redetermination is described by Fairchild, Hoover, and Peters in the May issue of the *Journal of Research*, published by the U.S. Bureau of Standards. The method employed consisted in measuring the relative brightness of black bodies at the melting-points of gold and palladium, and calculating the upper temperature by means of Wien's law, which is equivalent to Planck's law for light and gives the spectral distribution of radiation from a black body. The melting-point of gold was taken as 1063°. The result obtained was $1553 \cdot 6 \pm 0 \cdot 5°$ C., and when all possible sources of error are considered, the melting-point of pure palladium is probably $1553 \pm 2°$.

Dielectric Constant of Desiccated Oxygen.—The change in the chemical activity of oxygen produced by prolonged drying is accompanied by an increase in the dielectric strength of the gas. Thus a greater potential is required to cause an electric spark to pass through the dry gas than through ordinary oxygen. An investigation to determine whether this change in properties involves a modification of the structure of the oxygen molecule with a consequent change in the specific inductive capacity, is described by Riley in the *Journal of the Chemical Society* for May. The method used was to compare the capacities of two similar condensers of the same dimensions, one containing carefully dried oxygen and phosphorus pentoxide, and the other oxygen passed over calcium chloride. By means of a thermionic valve apparatus the condensers were found to have the same capacity, and no change could be detected after ten months' exposure of the gas to phosphorus pentoxide. Hence, the chemical activity promoted by the presence of small traces of water does not appear to be connected with any change in molecular structure.

Magnetic Storms and Radio Signals.—A recent *Daily Science News Bulletin*, issued by Science Service, Washington, D.C., reports that at a meeting of the American Geophysical Union on April 23, Miss I. J. Wymore announced that the Radio Laboratory Department of the Bureau of Standards has discovered an interesting relation connecting magnetic storms and radio signals. When the radio signals from European stations are weaker than usual and the signals from nearer stations in America are louder, then magnetic storms may be expected. After a magnetic storm much stronger signals are received from distant stations. The conclusions were deduced from the records obtained by experiments made with the long waves used for high power trans-oceanic transmission. Several days before the maximum of the terrestrial magnetic disturbance the signals were weak when received at Washington. The trans-oceanic signals, however, received at Washington from Tuckerton, New Brunswick, N.J., and Rocky Point, L.I., were decidedly stronger at periods varying from two to four days before the magnetic disturbance.

Composition of Gum Arabic.—There are a number of substances, such as pectins, plant gums, hemicelluloses and mucilages, which appear to be formed by the influence of enzymes upon cellulose and may be termed acid polysaccharides. Comparatively little is known concerning the structure of these substances, and an account of an investigation of the composition of gum arabic in the May issue of the *Journal of the American Chemical Society* is therefore of considerable interest. The plant gums are usually the calcium, magnesium, and potassium salts of very complex organic acids, and arabic acid, obtained from gum arabic by hydrolysis, appears to be an aldobionic acid of formula $(C_{12}O_{20}H_{12})_n$. Among the products of further hydrolysis, rhamnose, *d*-galactose, *l*-arabinose, and *d*-glucuronic acid have been identified.

Synthesis of Chaulmoogric Acid from Hydnocarpic Acid.—Chaulmoogric and hydnocarpic acids are constituents of chaulmoogra oil, and are of great importance on account of their extensive use in leprosy therapy. Some years ago Power concluded that chaulmoogric acid is a homologue of hydnocarpic acid, and this has recently been confirmed by Stanley and Adams. They have synthesised chaulmoogric acid from hydnocarpic acid by successive conversion of the latter into the ethyl ester, the alcohol, bromide, and through hydnocarpylmalonic acid to hydnocarpylacetic acid. The latter showed no depression of the melting-point (68°) when mixed with pure natural chaulmoogric acid and had a rotation of $+61 \cdot 9°$. The amides prepared from the synthetic and natural products also had identical melting-points. This work is described in the *Journal of the American Chemical Society* for May, which also contains a paper by Hinegardner and Johnson on the preparation of chaulmoogrylresorcinol and some of its derivatives. The bactericidal properties of these compounds are being examined in the hope that they may be free from certain objectionable effects produced by prolonged use of chaulmoogric acids.

Long Period Forecasting.—A reprint has been received of a paper by E. T. Quayle on "Long Range Rainfall Forecasting from Tropical (Darwin) Air Pressures", which appeared originally last year in the *Proceedings of the Royal Society of Victoria*. The economic importance of this subject for a country with a rainfall so capricious as that of Australia is evident, and the results obtained are such as to suggest that the accuracy of forecasts of the early spring rainfall of Northern Victoria, based purely on Darwin pressure for the two winter months of June and July, renders these of genuine value. The relationship is a negative one, low tropical pressure being followed more than eight times out of ten by rainfall above the average, and it seems highly significant that the connexion is actually closer than that between synchronous pressure and rainfall for two-month periods. The relationship diminishes quickly when earlier or later periods are considered; thus between Darwin pressure for June and July and the rainfall of ten representative stations in Northern Victoria in August and September, the correlation coefficient is $-0 \cdot 79 \pm 0 \cdot 04$, while between May and June pressure and July and August rainfall the coefficient is only $-0 \cdot 65 \pm 0 \cdot 06$. For July-August pressure and September-October rainfall the coefficient is even smaller, namely $-0 \cdot 52 \pm 0 \cdot 07$. This detracts less from the value of the results than would be the case were the spring rainfall not of such particular importance in cereal production, and for the growth of the pasture. The relationship, it may be noted, is of the simple linear kind which justifies the use of the ordinary regression equation in the calculation of rainfalls for individual seasons, and offers some prospect of good results in the anticipation of the dreaded droughts. Presumably the clue to this relationship is to be found in the southward migration of the tropical low-pressure belt with the approach of the Australian summer, and it seems to imply a greater continuity in any abnormal feature of this belt than might have been expected. This aspect of the matter, interesting as it is from the theoretical side and from the possibility it holds out of unravelling the physical processes at work in the production of abnormal seasons, the author unfortunately does not follow up.

Annual Meeting of the Royal Society of Canada.

THIS meeting was held in Ottawa on May 20-22, in the Chateau Laurier. The president, Mgr. Camille Roy, Rector of Laval University, Quebec, addressed the Society on "Provincialisme intellectuel au Canada". Prof. J. C. Chamberlain, of Columbia University, gave, by invitation, the popular evening lecture on "The United States Government and International Relations". At the annual luncheon of the Society, brief addresses were given by Sir Robert Borden, the Hon. Wm. Phillips, United States Minister to Canada, the Hon. Jean Knight, Minister from France to Canada, and Sir Wm. H. Clark, British High Commissioner.

Prior to the delivery of the presidential address, the following gold medals were presented: The Flavelle Medal (science) to Prof. A. H. R. Buller, of the University of Manitoba, immediate past president, for his work on Fungi; the Lorne Pierce Medal (literature) to Mgr. Camille Roy, for his contributions to French-Canadian literature; and the Tyrrell Medal (Canadian history) to Prof. George M. Wrong, of the University of Toronto.

Thirty-one papers on historical and literary subjects were communicated in Sections I and II (French and English Literature and History).

Among the 150 papers communicated to the three scientific sections the following may be noted:

In Section III (Physics, Mathematics, Astronomy, and Chemistry) the sectional presidential address was given by Prof. Frank Allen, of the University of Manitoba, and was a summary of his twenty years' investigation of the laws underlying the response of the human nervous system to various types of stimuli. He has shown that a logarithmic law holds for such sensations as vision, taste, touch, and hearing, when the relation between intensity and frequency is measured. Weber's law has now been proved to hold for mechanical stimuli. The action of the nervous system is fundamentally the same for all types of stimuli. As a result of this series of researches, many psychological tests can now be placed on a true quantitative basis.

Drs. J. S. Plaskett and J. A. Pearce, in a paper on the rotation of the galaxy, conclude from analysis of 500 radial velocities of *B* type stars that the galactic system revolves in its own plane in a period of more than 10^8 years about a centre in the direction of Sagittarius some 30,000 light years away. Dr. C. T. Sullivan presented a simplified proof of an auxiliary theorem used in Bescovitch's solution of Kakeya's minimal problem. Dr. L. L. Dines dealt with the resultant of two power series in two variables. Drs. A. S. Eve, L. V. King, and L. Gilchrist presented papers on the practical and theoretical results of estimating the depths of an ore-body by electrical means in geophysical investigations. Dr. J. S. Foster dealt with results obtained in the study of the Stark effect in parallel and crossed magnetic and electric fields in helium. Prof. J. C. McLennan presented a large number of papers by himself and his associates on various spectroscopic investigations. The papers on the Raman effect in liquid hydrogen, liquid oxygen, and liquid nitrogen were of particular interest in that they confirmed the correctness of Dennison's view that hydrogen at low temperatures consists of two effectively distinct sets of molecules, symmetrical and anti-symmetrical.

Dr. E. F. Burton demonstrated a new and important method of measuring the moisture content in grains, woods, and tobacco. The device used is a critically adjusted oscillating system extremely sensitive to changes in conductivity caused by the presence of moisture in the materials investigated. Dr. J. A. Gray, speaking on cosmic rays, deduced from experimental results and theoretical considerations that it is not possible to account for the most penetrating type of the penetrating radiation on any hypothesis of the synthesis of atoms from protons and electrons.

Dr. O. Maass and his associates gave papers on hydrogen peroxide as an oxidising agent and as a solvent, on the liquid state as a catalyst, on the viscosity of carbon dioxide at low temperatures, and on absorption and diffusion of vapours through wood. Dr. G. S. Whitby and his collaborators dealt with colour reactions of caoutchouc and other unsaturated hydrocarbons, on polyindenes, and on various related subjects. Dr. R. H. Clark dealt with the preparation of alkyl chlorides from the corresponding alcohols, and with the oxidation of aromatic amino-groups. Drs. M. C. Boswell and R. C. McLaughlin gave the results of an investigation which suggests that the mechanism of the Deacon process is more complex than has been usually held.

In Section IV (Geology and Allied Subjects), Dr. R. C. Wallace, president of the University of Alberta, in his sectional presidential address, dealt with the educational aspects of the group of sciences covered by the section, and in particular with the place of geography in a university course. Physiographical papers were presented on the deepening of Burrard Inlet, B.C. (W. A. Johnston), the relationship of the St. Lawrence fault to the Palæozoic margin (Carl Fissler), and the mature valleys of the Labrador peninsula (H. C. Cooke). Palæontological contributions included the history of deposition in Canada in Silurian times (M. Y. Williams), an account of two new theropods from the Belly River dinosaur beds (C. M. Sternberg), and the faunas of the Triassic in the Upper Peace River area (F. H. McLearn). Studies in sedimentation were dealt with by E. M. Kindle (the inter-tidal zone of the Wash, England), and F. J. Fraser (the character of some heavy minerals in Canadian sediments). C. W. Knight presented evidence determining the age of the Nipissing diabase as pre-Cambrian. Other papers included the physiography and geology of Great Slave Lake (J. M. Bell), a new type of fibrous magnetite, and the characteristics of the olivine diabases of Keeweenawa age in the Canadian Shield (E. M. Moore), and a chemical study of the Sudbury intrusive, as evidence of differentiation in a single eruptive (T. L. Walker).

The presidential address in Section V (Biological and Medical Sciences) was given by Prof. F. J. Lewis, of the University of Alberta. Dealing with the broader aspects of plant ecology, he pointed out the importance of past investigations in New Zealand, Australia, and South Africa on various types of grasslands and the effects of burning and grazing upon them to a country like Canada in which grazing is a prominent feature of farming, and considered that study of soil moisture and soil aeration, especially as regards their effects on germination and the development of seedlings, is likely to explain much of the existing distribution of different types of vegetation. The remarkable parallelism between different types of woodland and grassland is of considerable economic importance, since grasses in an area may indicate the species and types of woodland for which that locality is most suitable and thus facilitate afforestation.

Prof. A. H. R. Buller, by employing the Barger capillary tube method, has shown that the osmotic

pressure of the cell sap of *Pilobolus* is about 5·5, and he and T. C. Vanterpool reported that the so-called secondary conidia of the stinking smut fungus are true basidiospores. Dr. W. P. Thompson and collaborators gave a series of important papers dealing with the cytological cause and genetical effects of shrivelled endosperm in species-crosses of wheat, chromosome homologues in wheat and *Ægilops*, and chromosome differences in the *vulgare* wheats.

Other papers included craniometrical studies involving a number of new cranial indices (John Cameron), data concerning the numbers of molecules in the red-blood corpuscle (A. T. Cameron), study of prostate extracts with an adrenine-like action (J. B. Collip), new evidence as to the true location of the respiratory centre, in disagreement with Lumsden's work (V. E. Henderson and T. A. Sweet), forelimb reflexes and their reciprocal muscular co-ordination (F. R. Miller), and the temperature limits of *Gryllobiatta* (E. M. Walker). Dr. F. C. Harrison gave an important communication on the cause of discoloration of the bellies of Pacific Coast halibut, which he showed to be due to *Ps. fluorescens* introduced by the ice used for packing the fish.

The meeting in 1930 will be held at McGill University, Montreal, under the presidency of Prof. A. S. Eve, Macdonald professor of physics in McGill University.

Afforestation of Peat Lands in Sweden.

FOR a considerable period the Swedish Institute of Experimental Forestry has devoted extensive research to the problem of draining peat and marshy lands for afforestation purposes. Numerous investigations have been carried out with the view of gaining increased knowledge of the various properties of peat soil types and their suitability to draining by the ordinary forest method of open ditches. The importance of this study to Sweden will be evident when it is remembered that half the total exports consist of the produce from her forests, and that it is estimated that there are some 3,000,000 acres of this type of land which can be made suitable for the growth of trees.

The methods of inquiry projected have been on several different lines. Earlier types of drainage ditches have been studied with their results; and special drainage operations have been undertaken on varying types of marsh and peat lands, which have been thoroughly investigated geologically, hydrologically, and biologically. Laboratory investigations have also been undertaken into the physical and chemical properties of various kinds of peat. The careful work thus carried out over a series of years may have some considerable importance to Great Britain, in parts of which extensive tracts of peat lands exist.

The results of the Swedish investigations have been published in the *Reports of the Swedish Institute of Experimental Forestry*, No. 24 (1927–28), the paper by Carl Malmström being entitled "Våra Torvmarker ur Skogsdikningssynpunkt". The author states that his paper gives a general review of the results that have been obtained in regard to the suitability of different types of peat ground for draining, both as to the possibilities of draining it with advantage and the qualities of the timber to be obtained from it after the operations.

Investigations into the possibility of extending the area of forests in Sweden were begun in the middle of last century, coinciding with the commencement of Sweden's exploitation of the forests to capture a share of the European trade in soft woods which were replacing the broad-leaved timbers. Amongst others, C. G. Indebetow, T. L. Bohnstedt, and Bishop C. A. Agardh advocated ditching as the method by which poor unproductive peat lands might be afforested; the latter stating that the removal of excess water by this means would also improve the local climate.

Towards the end of the nineteenth century, a further motive for carrying out this type of drainage operation arose, it being suggested that such drainage would prevent peat-formations from spreading over still healthy forest land. At the beginning of the present century, therefore, the inquiry was considered from the twofold point of view of improving boggy land and as a protective measure, in many cases considered essential to obtain enduring results from good forest lands. The protective idea originated in northern Sweden, where there are extensive areas of poor forest growth where the soil is covered entirely or in patches with carpets of *Sphagnum* and *Polytrichum commune*. The fear of the spread of this type of formation came to be applied to parts of southern and central Sweden, and particularly to areas, as for example in western Småland and north-west Dalecarlia, where widespread complexes of moss are to be found. The investigations by the Institute of Experimental Forestry so far carried out, in this latter direction, are said to have produced "incontestable evidence that at the present time the danger of any general process of rapid bog-formation affecting the forests of Sweden is slight". The caution is added, however, that "this does not mean that locally, *e.g.* in the case of neglecting to clean out ditches, the confluence of streams, deforestation, forest fires, etc., processes of bog-formation cannot take place comparatively rapidly".

The business of improving poor peaty and marshy land in Sweden by laying out a series of ditches has now many enthusiastic adherents, both government and private land owners, and the author deems it necessary, owing to failures which have been experienced, to voice some warnings. Difficulties, he says, very similar to those experienced by farmers when they have sought to utilise certain types of peat land for cultivation purposes, have been experienced by foresters. Just as the farmer learnt by sad experience that it is wasted labour to try to cultivate economically, for example, mosses with large superficial layers of entirely undisintegrated *Sphagnum* peat, the forester now realises that certain types of peat soil react extremely slowly, if at all, after draining; whilst others soon after draining show a considerable and enduring improvement in the forest growth.

On the subject of the amount of water to be drained off, it has been shown that varying types of peat soils display remarkable differences in this respect. Investigation work has accordingly been concentrated on the degree of moisture and the biological properties of peat ground and also on its productive capacity after draining from the forestry point of view, and it is hoped by this means to arrive at an even greater certainty in the selection of areas to be drained and also on the correct method of laying out the system of drains for particular types of peat and marshy areas. The necessity for protective drainage schemes having, as explained above, been proved to be of local importance only, the investigation work is now

concentrated on drainage for afforestation purposes and the work is confined to those classes of peat soil which have so far been shown to respond and to show, without too expensive and elaborate a drainage scheme, a considerable and lasting improvement within a short time. "Peat ground", says the author, "that is hard to drain off and poor in quality, or in which the reaction takes place too slowly, must obviously, according to the present views, be entirely abandoned. It is clear, however, that in the event of drainage operations becoming cheaper or forest products increasing in value, or should it be possible to reduce the administrative and transport costs of lumbering, the poorer types of peat ground may be advantageously treated." The author then deals at length with the drainage possibilities of peat ground, its qualifications for producing timber after draining, and finally considers the conditions governing the most important types of peat land where draining is to be undertaken.

On the subject of classifying peat ground for forestry purposes, Mr. Malmström says that experience has shown that it is not possible unreservedly to use the old schemes of differentiating the types, which were set up on the basis of the topography, the plant associations, or the evolutionary history of the peat ground. Some of these may usually be better than others, but exceptions to this rule have been found. Unfortunately, there is at present no possibility of forming any such judgment in a simple stereotyped way, such as with the guidance of a certain definitely determinable property in the virgin peat soil. The peat's power to react after draining is determined by many contributory factors; as, for example, the composition of the peat, degree of disintegration and porosity, fungal and bacterial life, climate, and, above all, the power of the peat to absorb and retain water.

There is, however, an empirical and, for practical purposes, satisfactory method of judging in advance the qualifications of peat ground for producing timber after draining. This consists in studying the vegetation produced on the peat in its natural state and taking special note of the presence or absence of certain plants. Luxuriant vegetation (especially dwarf shrubs and bushes) often provides a good indication as to the biological conditions of the ground; that is, of those intrinsic properties which, after draining, largely determine the success of forest production, although they are not apparent from direct observation of the plant community. The species of trees and certain bushes and shrubs are particularly helpful. Alder (*A. glutinosa* and *incana*) is a good indication on several types of peat; and spruce and birch may also serve as a sign, especially if the trees have a healthy and normal appearance. The spruce by itself is more uncertain, and where it is stunted and knotty usually indicates a soil unsuitable for drainage schemes. Willows, juniper, and dwarf birch (*B. nana*), if tall and flourishing, indicate peat soils worth draining. When the areas are treeless, experience has shown that the presence of certain grasses, sedges, and herbs will furnish an indication of the peat's disintegration and porosity, especially in south and central Sweden. Plants of this kind are high sedges (*Carices*) and various types of cotton grass (*Eriophorum*): when these are present and the peat is fairly well disintegrated, the area is suitable, whilst the reverse is the case with areas of more or less undisintegrated peat covered with cotton grass and *Scirpus cæspitosus*.

Mr. Malmström's paper may be regarded as a valuable aid in a most important and difficult problem in afforestation in which forest officers in several parts of Europe are vitally interested, and it will well repay a careful study.

University and Educational Intelligence.

BIRMINGHAM.—The Walter Myers travelling studentship for research in any branch of pathology approved by the selection committee is being offered. The value is £300. The holder of the studentship will be required to devote his or her whole time to research. Applications must reach the Dean by at latest Sept. 2.

EDINBURGH.—At the summer Graduation Ceremonial the honorary degree of Doctor of Laws was conferred upon Mr. J. B. Clark, formerly Headmaster of George Heriot's School, Edinburgh; Prof. E. S. Goodrich, Linacre professor of zoology and comparative anatomy, University of Oxford; Prof. A. V. Hill, Foulerton research professor of the Royal Society; Prof. C. E. Inglis, professor of mechanism and applied mechanics, University of Cambridge; Dr. A. P. Laurie, formerly principal of the Heriot-Watt College, Edinburgh; Sir James Walker, professor-emeritus of chemistry; and the Right Hon. Lord Woolavington of Lavington. The degree of Doctor of Science was conferred on Mr. John Mackie, for a thesis entitled "An Inquiry into the Tetrad-difference Method of Testing the Two-factor Theory of Intelligence"; Dr. Christina C. Miller, for a thesis entitled "The Slow Oxidation of Phosphorus"; Dr. Frederick Walker, for a thesis entitled "The Geology of the Shiant Isles"; and Mr. John M. Whittaker, for a thesis entitled "On the Stieltjes Integral and on the Expansions of Interpolation Theory".

The Court has appointed Mr. C. B. Williams to be Steven lecturer in agricultural and forest zoology in succession to Dr. Stewart MacDougall.

MANCHESTER.—Invitations are invited for the Amy Henrietta Worswick Fellowship, value £150, for the investigation of the causes and treatment of rheumatoid arthritis. Applications must reach the Registrar by Oct. 15.

ST. ANDREWS.—By a recent ordinance a chair of botany has been established in the University, placing under the new professor the Departments of Botany in the United College, St. Andrews, and in University College, Dundee. The lectureship in botany in Dundee and the assistant lectureship in the United College as presently existing are continued under the new arrangement, and it has been agreed that the first appointment to the new chair should be offered to Mr. R. A. Robertson, who was appointed lecturer in botany in the United College, St. Andrews, in 1891, and reader in botany in 1915. Mr. Robertson has accepted the offer and has been appointed as from Oct. 1 next.

THE Trustees of the Beit Fellowships for Scientific Research have made the following elections to fellowships tenable at the Imperial College of Science and Technology for two years 1929–30 and 1930–31, of the value of £250 per annum: Mr. N. S. Grace, University of Saskatchewan, Saskatoon, Canada, for physical chemistry; Mr. J. J. Green, Imperial College, for an investigation of the nature and cause of the breakdown in agreement between the theoretical and observed viscous fluid motion round a circular cylinder; Dr. F. K. V. Koch, Imperial College and Universities of Dresden and Munich, for the continuation of an inquiry into the solution tension of silver in solvents other than water, and the connexion between solution tension and complex formation. The Trustees have confirmed the awards for a second year to Mr. A. A. Fitch (geology); Mr. J. M. Frankland (metallurgy); Mr. E. C. S. Megaw (electrical engineering).

Calendar of Patent Records.

July 23, 1888.—J. B. Dunlop's patent for the pneumatic tyre is dated July 23, 1888. Though his invention had been anticipated in the year in which he was born, more than forty years earlier, by R. W. Thomson, the popularity of the bicycle at the later date provided a rapidly growing market for the new tyre, and it is on Dunlop's work and enterprise that the present industry is based.

July 24, 1874.—The game of lawn-tennis was gradually developed from the older games, tennis, rackets, and badminton, and its actual beginnings are hard to determine, but the first to formulate and codify definite rules and a lay-out for the court was Major W. C. Wingfield, who patented his game on July 24, 1874, under the name of 'Sphairistiké'. Wingfield's court was narrower at the net than at the serving lines, and this form was adopted by the M.C.C. committee when it published its rules in 1875, but the rectangular court with practically the present dimensions was general by 1877. The cloth-covered ball is due to John Heathcoat, the tennis-player.

July 25, 1698.—The first steam engine successfully to operate—for pumping water out of mines, one of the great problems of the day—was the invention of Thomas Savory, who was granted a patent on July 25, 1698, and published an account of the invention in 1702 in his book "The Miners' Friend". The life of the patent was extended for 21 years by Act of Parliament in 1699.

July 26, 1588.—Modern shorthand dates from the patent granted on July 26, 1588, for 15 years, to Dr. Timothy Bright, resident physician at St. Bartholomew's Hospital, which licensed him "to teache, imprynte, and publishe, or cause to be taughte, imprynted, and published, in or by character not before this time commonlye knowne and used by any other oure subjectes". In the same year Bright published a description of the system in his book "Characterie. An arte of shorte swifte and secrete writing by character". A specimen, dated 1586, is in the Lansdowne MSS. in a communication to Sir Robert Cecil.

July 26, 1810.—J. C. Dyer's patent for a nail-making machine, dated July 26, 1810, is an important landmark in the history of the nail industry. There was considerable difficulty in getting the machine adopted, but finally a company was formed in London to work the invention and works were opened. By 1817, the machine-made nails had become a serious competitor in the market, as is evidenced by a petition to the House of Commons, which, referring especially to Dyer's factory, directed attention to "the ruin of the trade and devastation of the country" that was being brought about by the new industry.

July 26, 1811.—A patent was granted on July 26, 1811, to Henry James and John Jones for a method of welding gun-barrels by means of a series of hammers and for a lathe for turning barrels instead of grinding them. Jones was later employed by the Russian government in the State Arsenal, where he re-designed all the machinery and organised the factory on the 'interchangeable' system.

July 26, 1907.—The Garratt articulated locomotive, which provides a very flexible engine and allows of a wide increase in the steam-generating capacity within the limits imposed by the width of the track and the loading gauge, was invented by H. W. Garratt, of London, and patented by him on July 26, 1907. The first engine of the type was made by Beyer, Peacock, and Co., in 1909, for the Tasmanian Government railways, and the development has since been continuous and rapid.

Societies and Academies.

LONDON.

Geological Society, June 12.—**E. Mackenzie Taylor**: Base exchange and its bearing on the formation of coal and petroleum. The discovery of a bed of vegetable débris containing both peat and fusain under a layer of alkaline soil in Egypt led to the investigation of the effects of the presence of sodium-clay upon the decomposition of organic matter by bacteria. The alkaline soil was shown to be a sodium-clay produced by base exchange between the clay and solutions of sodium chloride. As the result of hydrolysis, a continuously alkaline medium under anaerobic conditions was produced in which continuous bacterial action is possible as the acidic products of such action do not accumulate. Lignocellulose decomposes under these conditions, yielding a material with fusain properties. The decomposition of proteins and fats takes place in the alkaline medium, and, in addition, it has been found possible to decompose free organic acids by bacteria under these conditions. It was suggested that coal and petroleum have both resulted from the decomposition of organic matter by bacteria, under the alkaline anaerobic conditions provided by strata which have undergone base exchange with solutions of sodium salts and subsequent hydrolysis in fresh water. The conditions provided by such strata are favourable to continuous bacterial action, to the elimination of oxygen from the material, and to the accumulation of the decomposition products as the result of the sealing of the organic deposit.

Physical Society, June 28.—**Teresa J. Dillon**: The relation between hydrogen pressure and filament resistance in a tube containing glowing tungsten. When a tungsten filament in a tube containing hydrogen is caused to glow, the gas rapidly disappears while the resistance of the filament rises progressively. The latter phenomenon can be used to measure the pressure of the hydrogen. Chemical action probably takes place between the hydrogen and tungsten.—**Francis Lowater**: The band systems of titanium oxide. The bands extend toward the infra-red through some 800 A. farther than the range previously known. Bands in the orange, red and infra-red regions have been analysed into two systems, distinct from the blue-green system, one of these being due to the transition $^1\Pi \rightarrow {}^1\Sigma$, the other to $^3\Sigma \rightarrow \Pi^3$, the latter having the same final energy level as the blue-green system $^3\Pi \rightarrow \Pi^3$.—**F. D. Smith**: The absolute measurement of sound intensity. The sound is received with a moving coil receiver. The signal heard after suitable amplification is compared with the signal produced by a small known electromotive force applied to the receiver. When the two signals are equal in intensity a simple relation connects the total sound pressure on the receiver with the electromotive force. The phase of the sound can be determined with the aid of a phase-shifting transformer. Since the measurement is independent of the amplifying circuit, it is possible to use a high degree of amplification and very feeble sounds may therefore be measured.

LEEDS.

Philosophical Society, June 17.—**R. Stoneley**: Love waves of short wave-length. The calculation of the velocity of propagation of transverse surface waves involves a knowledge of the rigidity and density of the medium at all depths. The velocity of very short waves, however, is determined mainly by the properties of the layers near the surface; an asymptotic formula for such waves is developed which depends

on the surface values of the rigidity and density and of their gradients.—**A. O. Allen**: A simplified derivation of v. Seidel's aberration formulæ (2).—**E. C. Stoner**: Diamagnetism and space charge distribution. The diamagnetic susceptibilities corresponding to the space charge distributions obtained by the Hartree self-consistent field method are calculated for He, Li^+, Na^+, K^+, Rb^+, and Cl^-. Except for Cl^-, there is very satisfactory agreement with experiment.—**R. Whiddington**: (1) Some new discharge tube phenomena. Experiments are described using a straight argon-filled discharge tube showing moving striations. There are at least four types of moving striations from flashes possible at one pressure, the type produced depending on the current employed. The change from one type to another is accompanied by an unstable system which is described but not explained. With a steady source of potential applied to the tube, the majority of the current is steady, but superposed on this steady current is a slight flicker amounting to a small percentage only of this whole current. Oscillograph measurements of this flicker show interesting variations of wave form with change of total current. These changes again are described but not explained. (2) A note on the use of the cathode ray oscillograph. A cathode ray oscillograph is often used for indicating the wave form of alternating currents by the associated use of a winking Osglim lamp. The winking frequency and the alternating current frequency must bear some simple integral ratio for this method to be applicable. For certain experiments it was found desirable to superpose a time mark of 50,000 frequency on that of the Osglim lamp so that the trace corresponding to the alternating wave would be segmented at equal time intervals, presenting an appearance somewhat like that of a string of beads. A method of carrying this out is described in which an oscillating valve circuit of about the desired frequency is suitably linked to the lamp, the frequency ratio of the two being again some simple multiple.—**R. Gane**: Carbohydrate content of detached partially shaded leaves. Sucrose and reducing substances are estimated in the distal, median and proximal portions of leaves isolated from the plant; the median portions had been shaded, whilst the rest of the leaf had been exposed to light. Certain differences in the sugar content then found in the leaf seem to be associated with the shading, but the differences do not seem adequate to explain the complete failure of starch to appear in the shaded strip. The distribution of sugars in plantain leaves thus treated, and in those in which the main veins had been removed, suggests that sugars can still move into the shaded region from illuminated ones, in spite of the dislocation of the vein system.—**W. Garstang**: On the dextricolic condition in Tunicates. The author republishes two figures from Barrois which establish the dextricolic condition of *Anchinia* buds, recently disputed by Van Wijhe. Their 'neural cord' is a 'neurogenital cord', comparable with that of *Aplidium* (Brien), but lying in a dextral, instead of a sinistral loop of the gut,—a complete *situs inversus*. The key to this condition is sought in the origin of salps and doliolids from colonial (pyrosomatoid) ancestors, and in the part played by subsequent rearrangements of the gut in balancing the body of free zooids for a locomotive career.

PARIS.

Academy of Sciences, June 10.—The president announced the death of M. Georges Lecointe, *correspondant* of the Academy for the Section of Geography and Navigation.—**Maurice Hamy**: A particular case of diffraction of the solar images at the focus of a telescope. It has been shown in earlier communications that the problem requires the calculation of some very complex double integrals. The evaluation of one of these integrals is dealt with in the present paper.—**Charles Moureu, Charles Dufraisse, and Léon Enderlin**: Researches on rubrene. A new oxide of rubrene. It is known that rubrene can fix a molecule of oxygen giving the oxide RO_2, readily dissociable into rubrene and oxygen. The preparation of another oxide, RO, is now described. This is more stable, is not dissociable into its constituents, but can be reduced to rubrene with ordinary reducing agents. It cannot be converted into the oxide RO_2. There is a close analogy between rubrene, the oxides RO_2, and RO and hæmoglobin, oxyhæmoglobin and methæmoglobin. It is concluded that the characteristic properties of hæmoglobin are not necessarily due to the presence of an atom of iron.—**V. Grignard and Tchéoufaki**: New researches on the additive properties of the α-diacetylene hydrocarbons. Experiments on the products formed by the addition of bromine, hydrobromic acid, and hydrogen to these diacetylene derivatives.—**Jules Drach** was elected a member of the Section of Mechanics in the place of the late J. Boussinesq.—**A. Gelfond**: Picard's theorem.—**Josef Mikuláš Mohr**: The absolute velocity of the sun.—**P. Salet**: The constancy of the velocity of light.—**Holweck and Lejay**: The preliminary study of a quartz tuning fork in a high vacuum. In the apparatus described, once the fork is started in oscillation, several hours elapse before the amplitude of the oscillations is reduced to one-half. The period was proved to be independent of the amplitude and constant within the limits of the accuracy of the measurements, about 0·0001 sec. Possible applications of the instrument are suggested.—**C. Raveau**: The rule of the four directions: Chatelier's principle.—**Henri Chaumat**: Electrostatic machines working with condensers.—**Gaston Rapin**: Attempts at the direct electrolytic preparation of ammonium permanganate. With an anode formed of silico-manganese in an ammoniacal solution, ammonium permanganate can be prepared directly, but on account of the low electrical conductivity of the ammonia solutions the method is of theoretical value only.—**S. Rosenblum**: The fine structure of the magnetic spectrum of the α-rays. The α-rays emitted by the radioactive substances radium-A, -C′ and thorium-C′ have been examined: the velocities of the α-rays attributed to these bodies are very homogeneous.—**F. Vlès and A. Ugo**: Some properties of the electromotive forces developed in contact with aqueous solutions of electrolytes of variable *p*H and salinity.—**Georges Fournier**: A magnitude permitting a new classification of atoms. Neither the atomic number N, nor the atomic weight A, completely defines an atom. The quantity $U = \frac{3}{4}A - N$ is suggested and is regarded as representing its filiation capacity.—**Guy Emschwiller**: The action of the zinc-copper couple on methylene iodide. In ether solution, ethylene is evolved and an organozinc compound formed. The latter appears to be zinc-iodomethyl iodide, ICH_2ZnI. With iodine, methylene iodide is regenerated; with water, methyl iodide, zinc hydroxide and zinc iodide are produced.—**Henri Moureu**: The tautomerism of the α-diketones. Heat of transformation of the isomers. The heat of transformation of the α-diketones (methylbenzylglyoxal, phenylbenzylglyoxal) is of the order of 2·5 large calories per molecule. This was determined in two ways, one based on the thermodynamic relation between the heat of transformation and the thermal variation of the equilibrium constant, the other on the heats of combustion.—**Jacques Bourcart and A. Keller**: The geological

results of the Augiéras-Draper Sahara expedition (Cretaceous and Eocene).—**Henri Erhart**: The nature and origin of the soils of Madagascar.—**Charles Rabot**: The abnormal arrival of icebergs on the north coast of Norway. For the first time on record, numerous icebergs (from Nova Zembla or Franz-Joseph Land) have appeared on the north coast of Norway during May last.—**R. Bureau**: Pressure and temperature by radiotelegraphy.—**Roger Heim**: The vasiform apparatus (*hyphes*) of the Agaricaceæ.—**Robert Lemesle**: The embryogeny of the Elatinaceæ. The development of the embryo in *Elatine Alsinastrum*.—**J. Loiseleur**: The modifications of the collagen substances under the action of the radiation from radioactive bodies. The β-radiation of radium or of radon effects a profound alteration in the colloidal state of collagen substances; salts of the heavy metals (lead acetate, gold chloride) sensitise the collagen to the action of the radiation. The phenomenon is independent of the temperature between 0° C. and 37° C. and is proportional to the intensity of the radiation.—**Lamberton**: The Archæoindris of Madagascar.—**Robineau** and **Contremoulins**: Examples of syntheses and protheses in bone, in metal uncovered or covered with rubber, established on metroradiographic data. Observations continued over several years show that the tolerance of the organism is complete if the mounting on the bone is correctly carried out.

CAPE TOWN.

Royal Society of South Africa, April 17.—**J. L. B. Smith** and **R. H. Sapiro**: Some derivatives of thiazole.—**G. E. Hutchinson, G. E. Pickford**, and **J. F. M. Schuurman**: Report on the natural history of pans and other freshwaters of the Transvaal (see also NATURE, June 1, p. 832).—**H. N. Dixon** and **H. A. Wager**: New and noteworthy mosses from South Africa.—**B. F. J. Schonland**: Thunderstorms and the penetrating rays. The main feature of the instrument used is an electroscope in which the moving part is a very light mica mirror suspended by two fine strips of gold leaf. Measurements of the intensity of the penetrating radiation underneath five active thunderstorms did not differ appreciably from measurements made during periods of fine weather.—**W. A. Jolly**: On recording lymph-heart beats. The work was undertaken with the object of studying the action of the lymph-hearts in Anura when the conditions are as nearly as possible normal. The method employed is that of the optical lever. A minute fragment of silvered cover-glass is placed on the skin—to which it adheres—where the impulse is most distinct, and a beam of light reflected from this mirror is focussed on the slit of a photographic recorder furnished with a roll of sensitised paper. The beat of the lymph-heart recorded in this way is remarkably regular. The beat action is not continuous, but shows periods when it becomes very small or ceases altogether.

PRAGUE.

Czech (Bohemian) Academy of Arts and Sciences (second class, Natural Sciences and Medicine), April 12.—**Fr. Ulrich**: Variscite and barrandite from Třenice, near Zbiroh.—**J. Švéda** and **R. Uzel**: Determination of tin by rapid electro-analysis. After a critical examination of electro-analytical methods for tin, the authors have worked out as the most reliable (within 0·32 per cent tin) the procedure in which tin is deposited electrolytically from acid oxalate solutions of stannous and stannic salts in the presence of hydroxylamine.—**J. Bašta**: New aspects of the stability, resistance, and fragility of rails and wheels in railway engineering.

May 31.—**J. Wolf**: The organic cement substance of the bone and of the dentin.—**V. Tůma**: Histological changes in rats during avitaminosis.—**J. Janatka**: The development, structure, and significance of the nucleus pulposus of the intervertebral discs.—**J. Nešpor**: Differentiation and de-differentiation of the tissue cultures from the viewpoint of the vitality measurements.—**F. Chudáček**: Calcification of the costal cartilages.—**V. Janko**: The insular tissue of the adult pancreas of the Cyprinides, its form and its relation to the excretory system.—**M. Uher**: The development of the nervous elements *in vitro*.—**M. Mikan**: A certain Cremona correspondence in quadri-dimensional space.—**J. Sobotka**: A contribution to the solution of the generalised problem of Apollonius.—**J. Charvát** and **D. Gjurič**: The cause of Basedow's glycosury.

ROME.

Royal National Academy of the Lincei, April 21.—**V. Volterra**: Observations on hereditary phenomena.—**G. Loria**: The scientific manuscripts of Francesco Siacci.—**A. Tonolo**: Classification of the surfaces of Hilbertian space, the 2-tangent space of which is of four dimensions (1).—**L. Fantappiè**: Linear functional equations in the complex field.—**G. Mammana**: Certain applications of the theory of the decomposition of linear and homogeneous differential expressions to the study of homogeneous linear differential equations.—**Pia Nalli**: Derivation of a tensor along a line.—**A. Mambriani**: A theorem relative to ordinary differential equations of the second order.—**G. Scorza-Dragoni**: A particular differential equation.—**E. Pini**: The existence of integrals of ordinary differential equations.—**D. Pompeiu**: The unicity of the prolongation of harmonic functions.—**A. Palatini**: Einstein's new theory. By means of his new theory, and starting from a principle of Hamilton with an appropriate universal function, Einstein has arrived at satisfactory analytical results. These are, however, only a first approximation, and the methods adopted do not render it easy to follow the corresponding exact equations, which have not yet been obtained. In the present note it is shown how, by the systematic use of known operations, without further formal complications, such equations are readily derivable.—**L. Genovese**: Comparison of the photographic magnitudes of various zones of the Astrographic Catalogue.—**A. Belluigi**: Simple and rapid processes of topographic correction.—**C. Mineo**: Relations between the parameters of terrestrial ellipsoids and the values of gravity.—**I. Ranzi**: Phenomena of negative resistance in a diode subjected to a magnetic field.—**A. Occhialini**: The charge of emission centres as shown by the polarity of the electrodes. The results of experiments with magnesium, mercury, and lead show that, for each element, the ratios between the lengths of the lines for positive and negative polarity are equal for lines emitted from centres having the same charge, and different, and increasing with the order of ionisation, for lines emitted from centres ionised differently. These results may be utilised for distinguishing spark lines according to the order of ionisation of the emitting atom.—**S. Di Franco**: Natrolite from Viagrande (Etna). Crystals of natrolite found in the cavities of a very old, reddish lava show the specific gravity 2·19-2·21 and the axial ratios $a : b : c = 0{\cdot}978523 : 1 : 0{\cdot}353626$, which agree well with the measurements made by Brögger on Norwegian natrolite. No deviation in the direction of extinction is observable. Most of the water present in the mineral is expelled within a somewhat narrow range of temperature, namely, 290°-305°.—**M. Comel**: The

physiological action of strontium. Continued endomuscular administration of strontium hexose-oxypropionate to fowls causes a characteristic intoxication developed at the expense of the nervous system. The first symptom is wasting accompanied by a voracious appetite, nervous changes appearing later. The symptoms as a whole are reminiscent of those produced by lack of vitamin B and are to some extent attenuated by administration of this vitamin.—C. Guareschi: The otocysts of anuran amphibia considered as a mosaic system.—S. Pastore: A special method of staining malaria parasites.

Official Publications Received.

BRITISH.

City and Guilds of London Institute. Annual Report of the Council to the Members of the Institute, 1928. Pp. xlix+72. (London.)

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 12: Technological Reports on Standard Indian Cottons, 1929. By A. James Turner. Pp. iv+125. (Bombay.) 2 rupees.

Report of the Nineteenth Meeting of the Australasian Association for the Advancement of Science (Australia and New Zealand). Hobart Meeting, January 1928. Edited by Clive E. Lord. Pp. xl+707. (Sydney, N.S.W.)

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 2, No. 14: Studies on the Scottish Marine Fauna; The Fauna of the Sandy and Muddy Areas of the Tidal Zone. By A. C. Stephen. Pp. 291-306. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 2s.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1195: A Mechanical Method for Solving Problems of Flow in Compressible Fluids. By G. I. Taylor and Dr. C. F. Sharman. Pp. 21+1 plate. 1s. net. No. 1197 (Ae. 358): Wing Flutter Experiments upon a Model of a Single Seater Biplane. By W. G. A. Perring. (T. 2684.) Pp. 20+10 plates. 1s. 3d. net. No. 1216 (Ae. 375): The Lift and Pitching Moment of an Aerofoil due to a Uniform Angular Velocity of Pitch. By H. Glauert. (T. 2687.) Pp. 9+2 plates. 9d. net. No. 1219 (M. 59): Investigation into the Proposed Use of a Sand Cast Test Bar for Specification Purposes for Aluminium Alloys. By Dr. W. Rosenhain and S. L. Archbutt. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (A. 55.) Pp. 9. 6d. net. No. 1225 (Ae. 380): Wind Tunnel Tests of a R.A.F. 30 Wing fitted with a Self-setting Slotted Wing (Pilot Plane). By F. B. Bradfield and S. Scott Hall. (T. 2471.) Pp. 12+4 plates. 9d. net. No. 1226: The Characteristics of a Tapered and Twisted Wing with Sweep-back. By H. Glauert and S. B. Gates. (T. 2730.) Pp. 19+4 plates. 1s. net. No. 1236 (Ae. 391): The Control of the Fokker F. VII.-3M Aeroplane. Interim Report by the Stability and Control Panel, with an Appendix giving Précis of Pilots' Reports. (T. 2408.) Pp. 5. 4d. net. (London: H.M. Stationery Office.)

Cambridge Observatory. Annual Report of the Observatory Syndicate, 1928 May 19–1929 May 18. Pp. 3. (Cambridge.)

Journal of the Royal Microscopical Society. Series 3, Vol. 49, Part 2, June. Pp. 91-209+xvi. (London.) 10s. net.

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 13, Part. 1. Pp. 69+15 plates. Vol. 13, Part 2. Pp. 71-121. (Pretoria.)

Department of Scientific and Industrial Research. Report of the Forest Products Research Board, with the Report of the Director of Forest Products Research, for the Period ended 30th September 1928. Pp. v+71+10 plates. (London: H.M. Stationery Office.) 3s. net.

Association of Technical Institutions. Paper read at the Summer Meeting, June 27th, 28th and 29th, 1929, on "The Relation between the Technical College and the Local University", by Principal W. A. Richardson. Pp. 19. (Loughborough: Loughborough College.) 6d.

FOREIGN.

Proceedings of the Imperial Academy. Vol. 5, No. 5, May. Pp. ix-xii+183-221. (Tokyo.)

Instituto Central Meteorológico y Geofisico de Chile. Publicación No. 38: Anuario Meteorológico de Chile de 1925. Pp. iv+163. (Santiago.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 10, 1928. 2: Nederbörden i Sverige. Pp. 160. (Stockholm.) 5.00 kr.

Jahresbericht der Hamburger Sternwarte in Bergedorf für das Jahr 1928. Erstattet von Dr. R. Schorr. Pp. 26+4 Tafeln. (Bergedorf.)

The Rockefeller Foundation. A Review for 1928. By George E. Vincent. Pp. 54. (New York City.)

Department of the Interior: Bureau of Education. Bulletin, 1929, No. 4: Illiteracy in the Several Countries of the World. By James F. Abel and Norman J. Bond. Pp. vi+68. (Washington, D.C.: Government Printing Office.) 15 cents.

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Technical Bulletin No. 98: Further Studies on the Value of Non-virulent Living Culture Vaccination of Cattle against Brucella Abortus Infection. By I. Forest Huddleson. Pp. 11. Chart Section of Technical Bulletin No. 98: Herd Charts. By I. Forest Huddleson. Pp. 15. (East Lansing, Mich.)

Smithsonian Miscellaneous Collections. Vol. 73, No. 6: Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 105 to 114. (Publication 3016.) Pp. 26. (Washington, D.C.: Smithsonian Institution.)

Cornell University: Agricultural Experiment Station. Bulletin 470: Pollination of Greenhouse Tomatoes. By H. W. Schneck. Pp. 60. Bulletin 471: An Economic Study of Retail Feed Stores in New York State. By E. A. Perregaux. Pp. 61. Bulletin 472: Sizes of Purchasing Centers of New York Farm Families. By Helen Canon. Pp. 15. Bulletin 473: The Cost of Handling Fluid Milk and Cream in Country Plants. By C. K. Tucker. Pp. 119. Bulletin 474: The Fumigation of Greenhouses to destroy Insect Pests. By Glenn W. Herrick and Grace H. Griswold. Pp. 20. Memoir 118: Wheat Prices and the World Wheat Market. By Vladimir Prokopovich Timoshenko. Pp. 100. Memoir 119: Prices of Fertilizer Materials, and Factors affecting the Fertilizer Tonnage. By Edmund Ellsworth Vial. Pp. 159. Memoir 120: A Physiological Study of Dormancy in Vetch Seed. By John Paul Jones. Pp. 50. Memoir 121: Variation and Correlation in the Appendages of the Honeybee. By E. F. Phillips. Pp. 52. Memoir 122: The Effect of Freezing on the Catalase Activity of Apple Fruits. By D. B. Carrick. Pp. 18. Memoir 123: Three Rust Diseases of the Apple. By H. E. Thomas and W. D. Mills. Pp. 21. (Ithaca, N.Y.)

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 68, No. 1. Pp. 68. (Philadelphia, Pa.)

The List of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Pp. 28. (Philadelphia, Pa.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 13, No. 2. Pp. 17-33+plates 9-10. (Tokyo and Sendai: Maruzen Co., Ltd.)

Proceedings of the United States National Museum. Vol. 74, Art. 11: Synopsis and Description of North American Tadpoles. By A. H. Wright. (No. 2756.) Pp. 70+9 plates. Vol. 75, Art. 1: Mammals from China in the Collections of the United States National Museum. By A. Brazier Howell. (No. 2772.) Pp. 82+10 plates. Vol. 75, Art. 24: Tertiary Fossil Plants from Colombia, South America. By Edward W. Berry. (No. 2795.) Pp. 12+5 plates. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Constable Announcements. Summer–Autumn 1929. Pp. 12. (London: Constable and Co., Ltd.)

The Cambridge Bulletin. No. 63, June. Pp. 24+4 plates. (Cambridge: At the University Press.)

Catalogue of Cine Cameras and Projectors. Pp. 16. (London: Sands Hunter and Co., Ltd.)

McGraw-Hill Books on Radio Engineering, Telegraphy and Telephony. (List 11, second edition.) Pp. 10. McGraw-Hill Books on Astronomy, Mathematics, Meteorology, Physics. (List 13, second edition.) Pp. 16. (London: McGraw-Hill Publishing Co., Ltd.)

Diary of Societies.

TUESDAY, JULY 23.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY.—Summer Meeting at Dartmouth (jointly with the Devonshire Association) to Commemorate the Bicentenary of the Death of Thomas Newcomen (continued on July 24, 25, and 26).

THURSDAY, JULY 25.

ROYAL AERONAUTICAL SOCIETY (at Science Museum, South Kensington), at 9 P.M.—The Hon. W. P. MacCracken, jun.: Science in its Relation to Regulating and Promoting Civil Aviation (Wilbur Wright Memorial Lecture).

CONFERENCES.

JULY 23 TO 26.

BRITISH MEDICAL ASSOCIATION (at Manchester).

Tuesday, July 23, at 8 P.M.—Prof. A. H. Burgess: The Debt of Modern Surgery to the Ancillary Sciences (Presidential Address).

Wednesday, July 24, at 10 A.M.—Sections of Medicine, Surgery, Obstetrics and Gynæcology, Diseases of Children, Neurology and Psychological Medicine, Physiology and Biochemistry, Pathology and Bacteriology, Oto-Rhino-Laryngology, Ophthalmology, Radiology and Radio-Therapeutics, Venereal Diseases, Orthopædics, Tuberculosis (also at 11.30 A.M.), Public Health (also at 11.30), Occupational Diseases.

Thursday, July 25, at 10 A.M.—Sections of Medicine, Surgery, Obstetrics and Gynæcology, Diseases of Children, Neurology and Psychological Medicine, Physiology and Biochemistry, Pathology and Bacteriology, Oto-Rhino-Laryngology (also at 11.30 A.M.), Ophthalmology, Anæsthetics, Dermatology, Radiology and Radio-Therapeutics, Venereal Diseases (also in afternoon), Orthopædics, Tuberculosis (also at 11.30), Public Health, Occupational Diseases.

Friday, July 26, at 10 A.M.—Sections of Medicine, Surgery, Obstetrics and Gynæcology, Diseases of Children, Neurology and Psychological Medicine, Physiology and Biochemistry, Anæsthetics, Dermatology, History of Medicine, Medical Sociology.

At 7.30 P.M.—Prof. A. V. Hill: Experiments on Frogs and Men (Popular Lecture).

JULY 25 TO 31.

LEAGUE OF NATIONS UNION SUMMER SCHOOL (at New College, Oxford).

JULY 25 TO AUGUST 2.

FRENCH ASSOCIATION (at Havre).