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The Amani Research Institute.

THE announcement made in the House of Commons on June 10 by the Hon. W. Ormsby-Gore, Under-Secretary of State for the Colonies, that early steps are to be taken for the establishment of the Amani Institute in Tanganyika Territory and for its upkeep as a centre of scientific agricultural research for the benefit, first, of the British East African dependencies, and secondly, of tropical economic development generally, is a very welcome one, for which we have long been waiting.

The Amani Institute was founded by Germany in 1902. The Institute is situated in the Eastern Usumbara Mountains, about thirty miles from the port of Tanga, and is approached by railway as far as Sigi or by a good motor road. The main buildings, including the laboratories and most of the residences, are situated in a group at a height of about 3000 feet. The Institute grounds comprise some 600 acres, 200 acres of which are under cultivation and the rest are virgin forest. As the mean annual temperature at Amani is 67·8° F. and the average rainfall is 55 inches, the climate is very pleasant; it is a healthy place and very free from mosquitoes. The buildings consist of several residences and very good and well-fitted chemical, botanical and zoological laboratories, together with a herbarium and library and the various garden buildings. A full description of the Institute has been given in the *Berichte über Land- und Forstwirtschaft*, Band II., and in the *Jahresbericht des Biologischen Landwirtschaftlichen Instituts Amani* for the year ending March 1914. These records, with their accompanying plans, show that the Institute was designed on a scale more nearly appropriate to the needs of a territory, such as that it was intended to serve, than anything provided by the Government of a British Crown Colony.

The work carried out by the Institute while in German hands was of a very valuable character, for there was developed an admirable scientific establishment devoted to the intensive study of the problems connected with vegetable physiology, both on the nutritive and the genetic side, on the fungal and insect aspects of plant pathology, and also with regard to the chemistry of soils and of plants.

In establishing the Institute at Amani, Germany had created a research station comparable to the corresponding Institute at Pusa in India, to which India owes so much, and to the Institute at Buitenzorg in Java, which has so long served the Dutch East Indies as a central station for the study of the many problems in tropical agriculture in the East. Amani during its period of activity under German management showed that it was a worthy rival both of Pusa and Buitenzorg, and, had it been allowed to continue as it was begun, it would no doubt have been able to confer

benefits on eastern tropical Africa as great as those which already stand to the credit of the Indian and Javan establishments.

Ever since the Tanganyika Territory came into British hands, however, the Amani Institute has been in a very uncared-for condition. For the first few years a director was in charge of the establishment, but as he had no officers working under him his duties were rather those of a caretaker than a director, and it was not possible for scientific work of any value to be done there at all, especially as he had to see to the proper care of the valuable instruments, books and specimens in the laboratories. In addition to the Director there has been a head gardener or Curator, who has been responsible for the plantations and for all the gardening work. These two officers have been in sole charge of the Institute. Since the retirement of the Director, the Curator has been the only European at Amani; and it is satisfactory to know that he has maintained the Institute and the grounds, and has been given the necessary help to look after the herbarium collections.

Amani properly constituted would serve not only as a centre for research, but also would be a valuable place to which the scientific workers attached to the Departments of Agriculture could go in connexion with the various problems confronting them in the several departments, while research officers at Amani would be engaged in working out the problems brought to their notice by the agricultural officers throughout these Colonies.

Another point of great value in such a place as Amani would be that scientific workers from home and from other parts of the Empire would be able to work at the Institute on scientific problems, as was the case in the past, and in the same way that botanists and other scientific officers are now able to carry out their researches at Pusa or Buitenzorg.

The matter of the re-establishment of Amani has, we believe, been under consideration at the Colonial Office for some years, and it seems unfortunate that instead of taking direct action from home, the various Colonies have been consulted as to whether or not they considered Amani would be of any value to them. Amani should be essentially an Imperial rather than a local institution, and it should be so maintained and extended as to serve as an agricultural research institute for the conjoint benefit of all the British Colonies and Protectorates in East Africa. In order that the Institute should fulfil its functions in the best possible manner, it should be independent of the control of any Department of Agriculture in these Colonies and Protectorates.

The potential value of Amani to the East African dependencies is immense, and it is essential that the Institute should be placed on a proper basis with as little delay as possible.

The Protection of Wild Birds.

TWO years ago Viscount Grey of Fallodon introduced a Bill on this subject in the House of Lords, as was noticed in these pages at the time, but the measure did not succeed in becoming law before the dissolution. In the present Parliament a Bill has been introduced by the Home Secretary and at present awaits a second reading in the House of Commons. The new Bill closely resembles its predecessor, although the drafting and arrangement have been improved, and it likewise aims at giving effect to recommendations of the Departmental Committee which reported in 1919. It is intended to supersede all the existing legislation on its particular aspect of the subject, apart from the special Game Laws, and to secure uniformity, simplification, and greater effectiveness.

The Bill gives some general protection to all birds by the total prohibition of certain methods of destruction and capture involving obvious cruelty. Bird-catching is to be strictly regulated, and prohibited on Sundays throughout the year, and on highways and commons at all times. In addition, special protection is given to different species according to three categories into which all birds are for this purpose to be divided. Birds named in the first category, with their nests and eggs, are to be protected absolutely at all times. Birds named in the second category, with their nests and eggs, are to be protected absolutely during the close season. The third category comprises all other species; these, but not their nests and eggs, are to be protected during the close season except against the owner or occupier of the land and his agents. (The protection of nests is a useful innovation.) The general close season is from March 1 to August 11. The woodcock has a special close season from February 1 to August 31, and the nests and eggs of the lapwing are not protected against the owners and occupiers of the land before April 15.

The Home Secretary, and in Scotland the Secretary for Scotland, is to have power to vary the classification or the close season of any bird, either generally or locally. In particular, he has power to give the status of Category I. to all birds in any bird sanctuary; but he may make exceptions, which is a wise provision in view of the fact that the undue multiplication of a common aggressive species may be at the expense of the others which it is desired to protect. He may also grant exempting licences for scientific purposes. This is a useful provision, but care will be needed to discriminate between genuine investigators and the type of collector, especially of eggs, who levies special toll on rare species and does nothing to increase ornithological knowledge.

Permits are also to be necessary before any imported foreign bird may be released in Great Britain. The case of the little-owl has taught its lesson, for this alien has become a pest and a menace to other birds in some parts, and has also tended to discredit the native owls, which have in reality quite different habits. In the exercise of these various powers the Home Secretary and the Secretary for Scotland are to be aided by advisory committees. These bodies are already in existence, for their institution was a recommendation of the Departmental Committee which had not to await legislation.

The new Bill will introduce a welcome uniformity which is lacking under the present system whereby too much is left to the initiative of local authorities. In addition to administrative considerations, the migratory habits of very many species make it impossible to deal logically or effectively with questions of protection from a local point of view. Variations between one district and another have also brought the law into disrepute from its very complexity. In other ways, too, the new Bill is less cumbersome to administer and is simpler to understand.

Apart from simplification, the new Bill should be more effective than the present law. It increases penalties and the powers of the police. It also makes it easier to prove an offence. The onus is put on any person found in possession of illegally taken birds or eggs, and taxidermists are to keep registers of all specimens coming within the scope of Categories I. and II. Similarly, it will no longer be possible to expose "plover's" eggs for sale more than five days after the beginning of protection: an absurd anomaly will thereby be removed.

The new Bill is therefore greatly to be welcomed, and one may hope that with its official backing it may indeed come into operation on the date proposed, January 1, 1926. It may perhaps be criticised, however, on the ground that it does not go far enough. It is mainly uncommon birds that are listed in Categories I. and II., and there is not full protection for some of the common insectivorous species—for example, the swallow—which are universally admitted to be beneficial as well as beautiful. It may be answered that the law as a whole gains by avoiding the creation of too many offences, and in any event there will be power to add to the schedules without the difficulty of a fresh appeal to Parliament. The point may have importance when the question of international co-operation as regards migratory species again comes forward, as there is ground for hoping it will at an early date.

There are two general provisions which one misses from the Bill, although both were recommended by the Departmental Committee. It was proposed that the advisory committees were to conduct investigations into the economic status of various species, something corresponding to the Hungarian Institute of Ornithology or the U.S. Bureau of Biological Survey being contemplated; at present, it does not appear that the committees are to be given the necessary machinery for performing this function, and they are defined as being purely advisory. The Departmental Committee also stressed the necessity for providing watchers for bird sanctuaries, because an unguarded sanctuary becomes the obvious prey of collectors and pot-hunters and is therefore worse than useless. The cost of watchers at a few selected places would be trifling to the central or local authorities, but it is nevertheless a heavy burden upon the available voluntary sources of funds for this national work. A. L. T.

Egyptian Mathematics.[1]

The Rhind Mathematical Papyrus: British Museum 10057 and 10058. Introduction, Transcription, Translation, and Commentary by Prof. T. Eric Peet. Pp. iv + 136 + 24 plates. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 63*s.* net.

II.

AMONG the mathematical processes known to the Egyptians (for some few of which we have to go to the Berlin and Moscow papyri) were squaring and extraction of square roots, arithmetical progressions and simple geometrical progressions starting from unity, the solution of equations of the first degree, and a few simple cases of equations of the second degree. In geometry, or rather mensuration, they thoroughly understood the areas of square and rectangle; they knew pretty well how to deal with triangles, though precisely how much they knew is a more debatable matter; in a problem dealing with the truncated (isosceles) triangle, we recognise Hero's τραπέζιον ἰσοσκελές. They found the area of the circle by squaring $\frac{8}{9}$ of its diameter, a near approximation —giving $\pi = 3{\cdot}160$. . . . They knew the volume of the cube and rectangular parallelepipedon; they found the volume of a cylinder by multiplying its height into the area of its base; and one remarkable problem in the Moscow papyrus gives a correct solution for the frustum of a regular square pyramid. Their elaborate system of weights and measures Griffiths especially, and other writers, have sufficiently explained.

Towards the close of his admirable introductory chapter, Prof. Peet gives us a short but very interesting

[1] Continued from p. 902.

comparison between Egyptian mathematics and that of the pre-Semitic or Sumerian Babylonians. We know little or nothing of how this latter people worked their problems, for what they have left us consists of bare tables of multiplication and division, of squares, and of square and cube roots. But they were undoubtedly versed in elaborate calculations, and two points in their mathematical system stand out as of the highest interest. In the first place they used a sexagesimal notation, in which lie the roots of many things, including the division of the hour into 60 minutes, and of the circle into 360 degrees (apparently a "smoothing" of the 365 days of the year); Euler was using a pure Sumerian notation when he went on from minutes and seconds to tierces (just as Ptolemy did), and even to quarts, quints and sexts. The curious question arises whether this sexagesimal system was primitive, or was deliberately adopted for its convenience; and Prof. Peet, leaning to the latter view, shows that 10 remained a subordinate unit, and that even the numbers from six to ten are but derivatives of those from one to five. The second point, marking a very high grade of mathematical insight, was the use of a "positional notation," closely comparable to that which we ourselves inherit from the Moors. Thus, just as we understand, when we write 365, that the 3 has to be multiplied by 10^2, etc., so the Sumerian could write 32.12.43, and mean or assume that the 32 was multiplied by 60^2, and the 12 by 60; the whole number was expressed as elegantly in his notation as we express it by 115,963. The singular thing, however, is the apparent mixing up here of a decimal with the sexagesimal system; for the 32 was, literally, thirty-two, *i.e.* it was expressed by three tens and two units: the fact being that their notation had only two signs, a unit and a ten, and was in this respect no more advanced than the Egyptian.

Prof. Peet's short comparative sketch of Sumerian arithmetic contains many other curious things, into which we cannot follow him; it is a subject which becomes more interesting the more we know of it. On one of its by-paths we have Hilprecht's attempt to demonstrate that Plato's mystical "Number" has its roots in the old sexagesimal system, deep down in Sumerian arithmetic; it may fall short of convincing, as Prof. Peet declares, but it is very interesting indeed. The classical student may thank Prof. Peet for his short but excellent epitome of what Herodotus, Strabo, Diodorus, and a few other Greeks have to say regarding Egyptian mathematics. *Inter alia*, he comes to the conclusion that the famous *harpedonaptae*, or rope-stretchers, were no more than land-measurers; in other words, that they used their rope just as our surveyors use their "chain."

We need not try to epitomise the range of problems which the Rhind papyrus contains, much less to summarise the indispensable comments and explanations which Prof. Peet gives. But it may whet the student's appetite, and send him all the quicker to the book itself, if we quote as briefly as possible one or two actual problems. Let us begin with one of the problems of "division of loaves," which are merely simple exercises in the use of fractions. "To divide nine loaves among ten men. You are to multiply $\frac{2}{3}+\frac{1}{5}+\frac{1}{30}$ by 10.

The doing as it occurs:

1	$\frac{2}{3}\cdot\frac{1}{5}\cdot\frac{1}{30}$
/ 2	$1\frac{2}{3}\cdot\frac{1}{10}\cdot\frac{1}{30}$
4	$3\frac{1}{2}\cdot\frac{1}{10}$
/ 8	$7\frac{1}{5}$
—	—

Total, 9 loaves. There is it."

As so often happens the working is not given, but only the proof: how the share of each man, namely, $\frac{2}{3}+\frac{1}{5}+\frac{1}{30}$, is arrived at we are not told. But evidently the Egyptian, dealing with $\frac{9}{10}$ (or rather with the idea of $\frac{9}{10}$), saw that he could handle it better, break it up more easily into aliquot parts, when in the form $\frac{27}{30}$, *i.e.* $\frac{20+6+1}{30}$. He evidently found 30 a convenient *mokhraj*, and he uses it again and again, for his 7, 8, and 9 loaves. When he proceeds to verify, by multiplying his result by 10, we see how skilfully he uses his fractions, retaining only the aliquot parts; in his first duplication he sees at once, or knows from his tables, that $\frac{2}{5}=\frac{1}{3}+\frac{1}{15}$, that $\frac{2}{30}=\frac{1}{15}$, and that $\frac{2}{15}=\frac{1}{10}+\frac{1}{30}$.

Note the curious phrase "the doing as it occurs." Prof. Peet goes to some pains to justify his rendering; but Baillet (from whom he differs) is not the only scholar who has seen in these words the plain "Do thus," ποίει οὕτως, which Hero employs in a similar way, and which reappear once more in the late Greek of the Akhmim papyrus. Hero of Alexandria has a great place, and Diophantus of Alexandria has a greater, among Greek mathematicians; but they may both of them have been Egyptians after all. I have, by the way, my doubts (however little they may be worth) even of the great Archimedes—for Sicily has been time out of mind a meeting-place of many races of men. I once asked a learned Orientalist what he would make of the name Archimedes, were he told that it was an Arab name, with the "Al" before a rough breathing softened by corruption into *Ar*. Without a moment's hesitation he said "Al-Hamad, of course!" It would be strange indeed if Archimedes, as great a mathematician as ever lived, was just one of those learned Sicilian Maghrebim, such as long

afterwards are said to have taught Leonardo Pisano and Leonardo da Vinci himself.

"A quantity whose fourth part is added to it becomes 15." This is an example of what is commonly called the *hau*, or *heap*-calculus. The word *hau*, or *'h'w*, Prof. Peet describes as "a mathematical-technical term equivalent to our 'quantity'"; he calls it a good example of the concrete nature of Egyptian mathematics. The Sanskrit arithmeticians use a precisely equivalent name; the Arabs called it by a word meaning "possession," or "sum [of money]," a meaning which survives in the "*avere*" of Leonardo. These arithmetical terms are curious and interesting in themselves; and all the more because they are separate and distinct from another series with kindred meaning, which arose afterwards, including the Arabic *shay*, "the thing," Italian *cosa*, German *die Coss*, etc.; these latter terms came in with algebra—"la règle de *la chose*," as they called it in the early sixteenth century.

Coming back to our problem, the Egyptian proceeds as follows: "Reckon with 4: you are to make their (*sic*) quarter, namely 1: total 5." Here, as Rodet points out, the process is precisely that enjoined in the medieval (Moorish) arithmetics: Look for the smallest number such that we can take of it the fractions required, in the form of known numbers; and add these fractions to the number itself. "Reckon with 5 to find 15 . . . the result is 3. Multiply 3 by 4, etc." The problem is thus dealt with as one of simple proportion. The word which Prof. Peet translates "reckon with" (*w:h, w:h tp*) has, by the way, been the subject of much discussion; Prof. Peet's rendering is at any rate on the safe side, and his explanation seems to be quite new.

"I go three times into the *hekat* (bushel); a third of me is added to me, a third of a third is added to me, and a ninth of me is added to me. I return fully satisfied. What is it that says this?" The fractions are added together, and the whole is shown to amount to $3\frac{1}{2}+\frac{1}{18}$; by this quantity, then, the 1 bushel has to be divided, or rather, in the first instance, the *unit* has to be divided. After the usual process of "dimidiation," $\frac{1}{4}+\frac{1}{32}$ of the said amount are shown to sum up precisely to one; and it is then easily shown that, in one *bushel* of 320 *ro*, $\frac{1}{4}+\frac{1}{32}$ is equivalent to 90 *ro*. The whole procedure is purely arithmetical; there is no x, there is no equation—there is no algebra.

A more difficult problem is: "A hundred loaves [in arithmetical proportion] to 5 men, one-seventh of the first three men to the two last. What is the difference of share?" The *regula falsi* is applied: we are told, that is to say, to give one loaf to the first man; but we are then told, or told to suppose, the common difference to be $5\frac{1}{2}$—which is the crux of the problem. Prof. Peet says that "the trial numbers chosen are not really arbitrary, but are chosen because they were already known to be suitable for the purpose." Be that as it may, the old arithmetician would soon discover the required progression by his usual method of trial and error; starting with one loaf as the first man's share, and trying successively common differences of one loaf, two loaves, etc., he would not be long of finding when the three lowest terms were just one-seventh of the two highest. It is no difficult matter for us, nor was it perhaps for him, to see that under these conditions the common difference is always $5\frac{1}{2}$ times the lowest term.

The following simple problem illustrates some notable features. "To divide 3 *setát* of land into 5 fields. You are to operate on 5 *setát* to find 3 *setát* of land." Observe that whereas *we* should divide 3 *setát* by 5, to find so many *setát* or parts thereof, the Egyptian divides 3 *setát* by 5 *setát*, obtaining a pure number. He is right and logical in doing so, because his whole method consists in comparing two series of *numbers*, and demonstrating the equivalence between them, namely:

1	5
/ $\frac{1}{2}$	$2\frac{1}{2}$
/ $\frac{1}{10}$	$\frac{1}{2}$

Therefore, since $2\frac{1}{2}+\frac{1}{2}$ sum up to 3, so also do $\frac{1}{2}+\frac{1}{10}$ sum up to the fraction required. But in his proof, when he has to multiply that quantity by 5, he does not speak of $(\frac{1}{2}+\frac{1}{10})$ *setát*, for he knows that it is so much *land* which he is now multiplying, and he has no name or sign for $\frac{1}{10}$ *setát*; he has to translate his fraction at once into $\frac{1}{2}$ a *setát* plus 10 cubits of land. He has passed from pure number to land-measure, with its own appropriate notation or nomenclature.

The many more difficult problems, of mensuration of areas, volumes, etc., are too lengthy to be dealt with here; once more, we must refer the reader to Prof. Peet's book. Its value lies not only in the new matter which it contains, but in the clear and very readable account it gives of what we already knew; it will hold its own for many a day as the best account of Egyptian mathematics; it will add not a little to the high reputation which, as Craven fellow and Liverpool professor, as scholar, teacher and explorer, its author has already won. Prof. Peet has done all he claims to do, and from the Egyptologist's point of view his task is done; but I fancy that the historian of mathematics has still a vast deal to do in the *comparative* study of Egyptian and other early arithmetics.

D'ARCY W. THOMPSON.

Physiology for Zoologists.

Grundriss der vergleichenden Physiologie. Von Prof. W. von Buddenbrock. Erster Teil: *Sinnesorgane und Nervensystem.* Pp. iv+276. (Berlin: Gebrüder Borntraeger, 1924.) 14*s*.

THE first feeling of the reviewer in laying down this book by Freiherr W. v. Buddenbrock, professor of zoology at Kiel, is one of regret that it is not written in the English language so as to be more freely accessible to our university students of zoology. The publication of this comparatively elementary text-book may be taken as symptomatic of the growing appreciation on the part of zoological teachers of the importance of the physiological side of their subject.

The habit, widespread during the past few decades, of exponents of the morphological and the physiological sides of the study of living creatures to ignore one another, has had deplorable results in slowing down progress by limiting that breadth of vision upon which all great advances depend. The book under review is not alone in suggesting that the end of this unfortunate period is at hand, and that it will be succeeded by one in which the new generation of zoologists will realise fully the importance of combining morphology and physiology together in fertile union. A phrase in the author's preface suggests a possible danger which will have to be guarded against. As he correctly states, the present movement of zoology towards the physiological side is "a sound reaction" against the prevalent narrow morphology: the need will be to control this reaction and prevent it from going so far as merely to replace a relatively sterile morphological training by an equally sterile physiological.

The present volume, constituting the first part of Freiherr v. Buddenbrock's text-book, is devoted to the nervous system and is divided into two main sections, the first dealing with the senses and the second dealing with the physiology of the nervous system apart from sensation.

In the first of these the subject matter is treated according to the nature of the stimulus with which the particular sensation has to do—under such headings as "Light sense," "Mechanical sense," "Chemical sense," "Temperature sense"—each heading being in turn divided up under convenient sub-headings. Thus under the main heading "Light sense" we have special sections dealing with shadow-reflex, photokinetic reaction, effect of light upon the tonic contraction of muscles, effect on direction of movement, conditioning factors of phototactic movements, stationary orientation towards light, "compass" movement, appreciation of form, the eye as a piece of physical apparatus, accessory arrangements of the eye, colour sense, black as a sensation.

Under the heading "Mechanical sense" the author deals with touch, with the activities of such organs as the halteres of dipterous flies and the sensory tentacles of jelly-fish (concerned not with the setting free of definite reflex movements, but rather with the control of the ordinary movements of the body), with the sense of movement and the sense of position, the special activities of otocysts or statocysts in this connexion, and the sense of hearing.

"Chemical sense" is dealt with under the headings smell and taste. Reference is made to the interesting work by Matthes upon the power of sniffing, *i.e.* drawing a current of the external medium through the olfactory organ, but it should have been mentioned that this faculty makes its appearance for the first time in the vertebrate series, not in urodele amphibians, but within the group of fishes. The fact that Lepidosiren possesses this power was observed nearly thirty years ago, and the description given in the text of the behaviour of newts sniffing at pieces of earthworm under water is textually accurate for the behaviour of young Lepidosirens in similar circumstances. The manner in which the mechanism for sniffing has originated in evolution is also clearly indicated by one of the Dipnoi, namely, Protopterus, in its ontogenetic development.

The second half of the volume opens with a short résumé of the general physiology of the nervous system, and this is followed by a sketch of what is known regarding the special physiology of the more important groups of invertebrates—Cœlenterata, Echinodermata, Annelida, Arthropoda, and Mollusca. In each case the treatment is just what is wanted by the student of zoology—only such matters being gone into as appear to the author to be, in the present state of knowledge, of real importance. The student's interest is not smothered and his breadth of vision obscured by masses of detail.

This special part ends with a short section on Vertebrata, in which are brought out the more important points in which this group differs from the invertebrate groups already dealt with.

Differing as it does from preceding text-books on comparative physiology, Buddenbrock's book is, to a certain extent, a pioneer work. Misprints and slips in detail are comparatively few for a work of this character. The book is illustrated by simple, well-chosen figures. The treatment, and a good deal of the substance, is original.

While dotted about the pages of the book occur the names of investigators to whom we owe particular bits of knowledge, there is no attempt made to trace the historical development of the various parts of the

subject, nor are there given any references to literature. Some may count these omissions as serious faults, but to the present reviewer they serve to awaken distant memories of dry-as-dust lectures, consisting of critical digests of the work of successive investigators, which were particularly effective in killing interest, and he cannot but think Buddenbrock's method the better one. There are doubtless others who believe with him that modern biology has suffered much from its overwhelming literature. The easiest of all types of advanced teaching is that which consists of a series of excerpts from literature with more or less critical remarks attached, but it breeds a timorous, relatively sterile type of biologist who will either content himself with being a mere abstracter of other people's work or, if he takes up original research, will seldom achieve more than the mere addition of more detail to that already existing. Buddenbrock's book will leave its reader with the knowledge that comparative physiology is a real and live, if a young, science: it is one which, in the reviewer's opinion, should be read by all university students of advanced zoology.

Yorkshire.

Geology of Yorkshire: an Illustration of the Evolution of Northern England. By Prof. P. F. Kendall and Herbert E. Wroot. 2 vols. Pp. xxii+995+72 plates. (Leeds: Prof. Kendall, Moor Allerton; or H. E. Wroot, 99 Spencer Place, 1924.) 17*s.* 6*d.* net.

DIVERSIFIED beyond compare among counties, both in its surface features and in the range and exposure of its outcropping formations, Yorkshire has naturally given rise to a copious stream of geological literature, which has flowed unceasingly ever since the establishment of stratigraphical studies within it more than a century ago. The depth and strength of the current can be gauged well from this latest work, which is in all respects a powerful addition to the stream, with novel and serviceable attributes.

By a happy combination of thorough geological knowledge with skilful literary art, the authors have contrived to produce a work which, while helpful to the trained geologist, will appeal strongly to the much wider circle who, without high technical qualifications, desire to gain some understanding of the building and shaping of their county. While instructive about every formation in Yorkshire, it does not aim at giving a circumstantial account of the stratigraphy, but concentrates mainly upon the parts which have been particular objects of the senior author's researches, thereby introducing a touch of polemic which gives a spice wanting from impersonal compilations, however full and balanced. In the preface the authors plead for a free use of the imagination in order to lure recruits to the science; and their plea has much in its favour, always provided that the recruits do not follow suit too quickly, as they are rather apt to do.

Among the subjects thus accentuated are the reef-knolls and the underground drainage-channels of the Carboniferous Limestone country; the "wash-outs" of the Coal Measures; the growth-in-place origin of coal; the "cleat" in coal; the deltaic character of the Millstone Grit; the "brockram" of the Permian and other evidence for desert conditions in the rocks; the life-history of the fossil cephalopods; the components of the chalk; the development of the river-system; the Pleistocene glaciation, with special reference to the overflow channels and other evidence for glacial lakes; and various matters of economic interest.

The authors state their opinions, not "dogmatically as Articles of Faith, but as working hypotheses for the reader's own confirmation or rejection in face of the phenomena," and with this attitude they will doubtless welcome the criticism likely to be aroused at points which we have not space to specify.

The technical matter of the work is pleasantly relieved by anecdotal and personal touches, and by biographical sketches, with portraits, of most of the past workers in Yorkshire geology; so that the reader is provided with the history, as well as with the interpretation, of the stratigraphy. The work is divided into three parts: the first (655 pp.) being the main text, to which we have just referred; the second (70 pp.), a description of the geological sections and features to be observed along the principal railways; and the third (230 pp.), "Specimen days in Yorkshire," intended as a guide to a series of geological excursions covering every part of the county. In the last two parts the local descriptions serve to amplify and systematise the stratigraphical account in the main text, so that in one part or another the student is provided with a fairly full account of every formation. Fully illustrated with well-chosen and well-printed plates and text-figures, many reproducing the artistic geological photographs which we owe to the ripe judgment and skill of Mr. Godfrey Bingley, the work, beside its scientific consequence, cannot fail to arouse pleasurable memories in any one who has ever felt the spell of the Yorkshire scenery.

In these days of dear printing, the cheapness of the work is amazing, but is explained by the authors in the preface. Failing to find an amenable publisher or practicable terms for printing at home, they have had the printing done in Vienna, and are themselves the publishers and distributors.

The result has justified the experiment, as the typing is excellent and the misprints few and un-

important. The copy before us is bound as a single volume, but we understand that the work is now bound in two volumes and will be supplied in this form only, which is certainly the better way in view of the intent that Parts II. and III. are to serve as a local guide-book. For such a purpose the single volume is decidedly too bulky.

As a point of minor criticism, we may note that the dual authorship is curiously exemplified by the numerous instances in which the senior author is referred to by name or in the third person, a construction which unnecessarily accentuates the duality.

G. W. LAMPLUGH.

The Falkland Islands.

The Falkland Islands. By V. F. Boyson. With Notes on the Natural History, by Rupert Vallentin. Pp. 414+24 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1924.) 15*s.* net.

EARLY in the sixteenth century a group of islands to the east of Patagonia began to appear on charts. It is not clear who first sighted them, but Miss Boyson is inclined to give the honour to Amerigo Vespucci and to identify with the Falkland Islands the land which the Florentine astronomer claimed to have discovered in 1502. In any case, the history of the Falklands did not begin until the voyage of Cavendish and Davis in 1592. From then until the battle of the Falklands, Miss Boyson traces the varied history of the islands and the adventures of rival whalers and settlers which led to the curious claim of the Argentine to the sovereignty of the group, a claim that was maintained long after they had become a British colony inhabited entirely by British settlers.

From a scientific point of view, the second half of the book is of most interest in its full treatment of the cattle and sheep-farming and of the sealing and whaling in Falkland waters. To these chapters are added others on the climate and natural history. The cattle introduced by the early settlers eventually ran wild, but were gradually exterminated as sheep became the chief interest of the settlers. This occupation also led to the extermination of the Falkland Islands fox, which was said, with good reason, to attack and kill sheep. Whaling has now left the islands for the dependencies, and fur-sealing for many years has been prohibited on Falkland coasts in an attempt to preserve the few remaining fur seals, but in the past both occupations largely influenced the history of the islands.

The chapters on natural history are by Mr. R. Vallentin and are based on his own work and collections with some, but not complete, references to other workers in this field. The chapters on climate, stone rivers, and flora are, however, apparently by Miss Boyson. The remarkable stone rivers were originally attributed to volcanic action but now are generally explained by a downward creeping movement of water-logged soil, a process of solifluction during the ice age when the climate was not cold enough to allow glaciers to form but permitted a thick snow covering in winter. Miss Boyson scarcely touches on the problem of the former connexion of the Falklands with the arc of folding connecting South America with Graham Land. A problem of interest which she discusses is the so-called forest bed of coniferous tree-trunks discovered at West Point Island some years ago. Opinion now inclines to the belief that it is built of driftwood. If it is not, it certainly points to a change of climate in quaternary times. The volume is beautifully illustrated and provided with a good map. The historical part in particular is well documented. Altogether it is a work of great value and fills a distinct gap among authoritative works on the British Empire.

Our Bookshelf.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie. Band 1: Die Plastiden. Von Dr. Paul N. Schürhoff. Pp. iv+224. (Berlin: Gebrüder Borntraeger, 1924.) 14*s.* 9*d.*

THE volume under notice is one of a series on plant anatomy and cytology. Plastids are probably the most characteristic bodies in plant, as contrasted with animal, cells. As a compilation of nearly all that is known concerning the structure and physiology of plastids, this work will fill a useful place. The extent of the literature bearing on the subject may be judged from the literature list of more than 700 titles. The great range of plastid form and structure is considered for the different groups of plants, including leucoplasts and elaioplasts as well as the various forms of chromatophores. Under the heading "Constituents of Plastids" the chemical composition of chlorophyll and other pigments, such as fucoxanthin and the carotinoids, is briefly considered. The physiology of chloroplast movement and of greening are discussed, as well as such subjects as "complementary chromatic adaptation." Carbon assimilation, which has its seat in the chloroplasts, is considered at length as a process, and also in relation to the internal physiology and the external environment (light, temperature, and carbon dioxide content) of the plant.

In the final section on the "pathology of plastids" the phenomena of chlorosis, mottling, chimæras and similar topics are included. In this connexion not only the histological structure but also the hereditary behaviour is discussed. The relation of plastids to mitochondria is also considered in another part, but there is no allusion to the important work of Lindstrom and others on the inheritance of plastid differences in varieties of maize.

R. R. G.

Shaman, Saiva and Sufi: a Study of the Evolution of Malay Magic. By Dr. R. O. Winstedt. Pp. vii+191. (London, Bombay and Sydney: Constable and Co., Ltd., 1925.) 12*s.* net.

MALAYA has served as a melting-pot of many creeds as it has been the meeting place of many racial strains. Aboriginal tribes, Malays, themselves a composite people, Hindus, Buddhists, and Arabs have all contributed to the conglomerate which comes under the general term of Malay religion. For although in theory a strict Mohammedan, the Malay sees no incongruity in the inclusion of primitive charms among his invocations, and in the prominence, sometimes pre-eminence, of the magician in relation to the Moslem teacher. Although Skeat in his "Malay Magic" was well aware of the composite character of his material, any analysis, except incidentally or when essential to the exposition of his subject, lay outside the scope of his book. The beliefs of the Malays, however, invite, or rather demand, comparative treatment. How far, for example, is the remarkable prominence of the magician in Malay ritual to be regarded as characteristic of a stage of primitive belief? How far can it, as an accompaniment of a peculiar racial strain, be correlated with the highly-strung Malay temperament?

Dr. Winstedt's book is an invaluable, indeed, an indispensable, antecedent to comparative study. He has analysed the tangle into its component parts, describing first the development of the Malay from animist to Muslim, and then the beliefs and rites of each stage. His concluding chapter, which deals with the relation of the magician and all he stands for to the Sufi and Sufi pantheism, is perhaps the most valuable and its subject matter the least generally familiar in the book.

The Spirit of the Wild. By H. W. Shepheard-Walwyn. Pp. xx+220+38 plates. (London: John Lane, The Bodley Head, Ltd., 1924.) 12*s.* 6*d.* net.

THE author of this book possesses an unusual combination of qualities—a lively interest in and sympathy with animals, keen powers of observation, a facile pen, and a sense of humour. It is not surprising that they should have resulted in the most refreshing book on British mammals that we have read for some time. It is not that Mr. Shepheard-Walwyn has anything really new to tell, so much as the arresting and interesting way in which he puts on record his keen observations of living animals, imparting to the reader some of his own enthusiasm for and sympathy with them.

The author does, however, present a new view-point. His book contains twenty-two chapters, each dealing with one British mammal, and he has endeavoured to sum up in the titles to his chapters the outstanding trait in the character of the animal he is discussing, the driving force which directs its every action, which he calls its spirit. Thus the fox is directed by the Spirit of Craft; the mole, the Spirit of Energy; the vole, the Spirit of Vulgarity, and so on. It is an interesting point of view, and, whether one agrees with the author or not, one is bound to admit that he has managed to convey, both in the titles and in the subject matter of his chapters, a living picture of the animals described, and, on the whole, we should agree with his summing up of their characters.

The book is beautifully illustrated by a series of clear photographs, mainly by Mr. H. Mortimer Batten and Miss Francis Pitt, but including some by the author, Mr. R. Kearton and others. This is altogether a delightful book, and we hope it is not the last that the author will produce.

Probleme der Astronomie. Festschrift für Hugo v. Seeliger dem Forscher und Lehrer zum Fünfundsiebzigsten Geburtstage. Pp. iv+475+3 Tafeln. (Berlin: Julius Springer, 1924.) 45 gold marks.

IT will be a source of satisfaction to all astronomers that this bouquet of writings gathered in homage to Seeliger was published before his lamented death in December last. The volume consists of thirty-six papers, embracing subjects from abstract dynamics on one hand to the latest astrophysical problems, both experimental and theoretical, on the other. The value of the contributions is sufficiently guaranteed by the list of authors, and though selection is invidious, the names of Jeans, Eddington, Schwarzschild (presumably a hitherto unpublished fragment), von Zeipel, Eberhard, Kohlschütter, Plaskett, Emden, Bergstrand, Schlesinger and Shapley will give an indication of the standard maintained. Some of the articles consist entirely of original research. Others give a general summary of recent work in some particular branch—summaries not easily found elsewhere. As particularly valuable ones may be mentioned Ludendorff's "On the relations between the different classes of variable stars," and Guthnick's "Twelve years of photoelectric photometry at the Berlin Observatory"; also Strömgren's (of which the title had better be left untranslated) "Zu Durchmusterung des Probleme restreint." A paper by van Rhijn contains evidence throwing doubt upon the supposed non-existence of M-stars intermediate between giants and dwarfs. Many of the papers are such as can be read with ease by those not specialists in the particular subjects concerned. E. A. M.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1925. Edited by Sir John Scott Keltie and Dr. M. Epstein. Sixty-second Annual Publication; revised after Official Returns. Pp. xxxv+1531. (London: Macmillan and Co., Ltd., 1925.) 20*s.* net.

THE new edition of this indispensable work of reference appears with its unfailing regularity, and has, as usual, undergone complete revision in its voluminous statistics. As the world settles down there are fewer changes in territorial jurisdiction to record than in recent years, and the number of independent states has ceased to grow. The section on Arabia has been recast and contains a great deal of useful information of recent date. More Russian statistics are now given than was possible a few years ago. The bibliographies attached to each state are a valuable feature of the book, and they have shared the careful revision. Coloured maps show the new boundary between Britain and Italy in Jubaland, and the allied zones of occupation on the Rhine. The introductory tables give statistics of world production of coal, iron, and other commodities and facts concerning the League of Nations. In spite of its 1530 pages, the volume is not two inches thick, which adds to its convenience for reference.

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.*]

The Coherence of Superposed X-Radiations.

WHAT is probably the most remarkable conclusion from the investigation of the *J* phenomenon is that two superposed X-radiations produce effects which are not the sum of those of the two constituent radiations, but are due to the compound radiation as a whole. It is not merely that a constituent of one radiation produces effects in atoms traversed when those atoms are exposed to the action of one or more constituents of the other beam; it is much more than that. The compound radiation, so far as the *J* phenomenon is concerned, behaves as an entity with properties of its own dependent upon (average) penetrating power and not on constituent wave-lengths. This follows as a necessary consequence of the laws which we have found, and have already stated ("The *J* Phenomenon in X-rays," *Phil. Mag.*, May 1925). We have, however, just obtained the most direct and convincing proof of this.

The absorption of an X-radiation scattered from a plate of aluminium was studied by placing an increasing number of thin aluminium sheets in its path to an electroscope. It was found that at a thickness of 0·05 cm. of absorbing aluminium the intensity as measured in the electroscope suddenly dropped by about 7·5 per cent. This was the J_2 discontinuity, as it occurred when the average absorption coefficient $(\mu/\rho)_{Al}$ was about 2·0. Thick plates of aluminium were then placed behind the first scattering plate so that while the original radiation studied was unchanged, there was superposed upon it the more penetrating radiation from a much thicker layer, making the combined radiation (on the average) more penetrating. On filtering this combined radiation by aluminium as before, no discontinuity was observed at the stage found in the first experiment—that is, the discontinuity no longer occurred even in the absorption of that part of the radiation from the first scattering plate. Instead of this a discontinuity of the same magnitude (relative) occurred when the filtering sheets had a thickness 0·02 cm. which was the appropriate position for the discontinuity in the *radiation as a whole*. By "appropriate position" we mean the thickness of aluminium at which the beam as a whole reached the critical absorption coefficient characteristic of the absorber.

Thus two beams which, because of differing penetrating powers, exhibit the discontinuity at differing filtering thicknesses of aluminium, when superposed exhibit not two discontinuities at these thicknesses, but one discontinuity of double magnitude (*i.e.* unaltered relative magnitude) at a thickness between the two shown by its constituents. All this is perfectly consistent with our results from scores of experiments; the discontinuity occurs not at a certain wave-length but at a definite "absorption coefficient" for the whole beam—an absorption coefficient with which we are now perfectly familiar.

The phenomenon may perhaps be more clearly described as one dependent on something analogous to temperature of the X-radiation as a whole, though it is impossible as yet to see how far the analogy will take us. For "absorption coefficient" is more precisely the fractional rate of diminution of ionisation in air (or other gas) with the mass per unit area of aluminium traversed. This again is approximately the rate (fractional) of transfer of energy from the radiation to the matter through which it passes. (In the case of a fluid flowing with constant speed through a substance, this would be governed by temperature of the fluid.)

Indeed, all our experiments on the *J* phenomenon show detachment from mere wave-length and dependence on this absorption coefficient of radiation. The analogy goes further, however, for there is very strong evidence indeed that the *J* absorption discontinuities we have observed are of such a magnitude as just to compensate for a deficiency of absorption which under slightly different conditions takes place continuously. (Such discontinuities occur of course when a liquid is superheated or a vapour supersaturated: there takes place suddenly what would under favourable conditions have been a more gradual change of state.) Correspondingly, when the X-radiation is transmitted through matter, absorption does not take place at the rate which appears under slightly different conditions; but when the discontinuity does occur, the deficiency in absorption occurring previously appears quite suddenly. It is as though there were a sudden evaporation (or condensation) of the energy of radiation, when this is in an unstable state so far as its relation with the surrounding matter is concerned, the energy of the radiation being transferred to electrons in the matter traversed.

It ought not to be necessary to say that in the above experiment the whole process can be repeated in inverse order, any feature of it can be repeated, the discontinuities may be displaced,—in fact, the whole of the phenomenon is under perfect control. The magnitude of these discontinuities, too, is remarkably constant, a long series of experiments giving a drop of $(7·7 \pm 0·5)$ per cent. consistently. Again, we should emphasise that this experiment, though particularly controllable, accurate, and striking, only verifies what, in this laboratory, has been observed less directly in a hundred experiments. The conditions for this "coherence" and its limitations are at present being further studied.

We take this opportunity, too, of announcing that we are now able to show the three discontinuities J_1, J_2 and J_3 one after the other by progressive filtering of a selected X-radiation. Each is indicated by a drop of about 10 per cent. in the intensity of the radiation as usually measured. J_1 was first observed in a scattered radiation; J_2 in a characteristic radiation (*K* series); J_3 in a primary radiation. We now have them all exhibited in one radiation.

We shall describe elsewhere the application of the *J* phenomenon to scattered X-rays.

C. G. BARKLA.
GLADYS I. MACKENZIE.
University of Edinburgh,
May 30.

Radio Transmission Round the Earth.

A THEORY which would explain the facts of long-distance radio transmission must take into account the differences between day and night transmission, long- and short-wave transmission, etc., and must connect these with a plausible assumption with regard to the constitution of the upper conducting or refracting layer, which is believed to function as the chief agency in bending the rays round the earth.

The effect on transmission of such a layer, which has been shown by many eminent scientific men to account in an adequate way for the *bending* of the rays

round the earth, is determined entirely by its capacity for absorption of the energy of the rays which pass by or through it. G. N. Watson has shown that in the special case investigated by him, the absorption suffered by a wave travelling in the space between two concentric shells of resisting material is the same as it would have been had the bounding surfaces been plane instead of spherical. Thus to a fairly high degree of accuracy, absorption and bending are independent of each other, and, as is physically fairly apparent, we can calculate each independently of the other.

It should, therefore, suffice to the first approximation to determine the absorption in the more simple case of transmission between plane bounding surfaces, to get at least a rough measure of the actual absorption in the transmission of waves round the earth.

I should like to give here the results of such an investigation, especially as it seems to explain in a broad way all the main features of long-distance transmission in daytime. In this investigation a radially symmetrical transmitter was assumed to be situated on the earth's surface. At a height "H" above the earth a reflecting layer was postulated, and

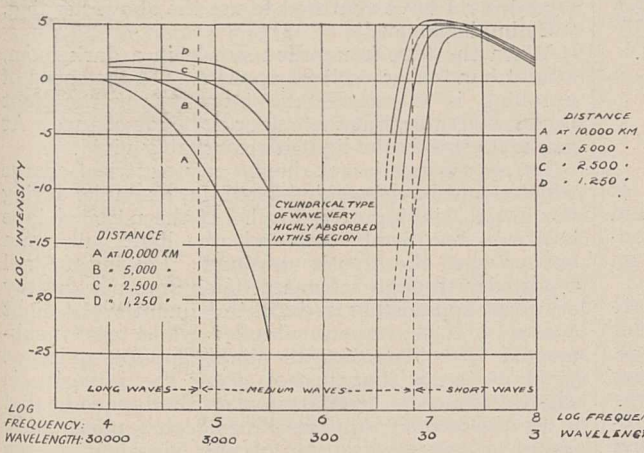

FIG. 1.

the complete problem of the spreading out of electromagnetic waves between the two layers was investigated for all values of electrical constants of the layer as well as for all wave-lengths in the radio range. The constants of the medium which enter directly into the equations are "resistivity" and "dielectric constant." These in their turn depend on the ionic mechanism of the conducting layer, according to the well-known relations of the ionic theory.

By assuming that in daylight the height of the upper layer is approximately 40 km., in accordance with the evidence given in a previous letter to NATURE (April 4), and that τ, the mean time between collisions, is of the order of 10^{-6}, we obtain results which, so far as measurements have been made, are in rough agreement with the observed facts of long-distance transmission. The theory indicates that there are in general two types of wave: first, a cylindrical wave which varies inversely as the square root of the distance, multiplied, of course, by a suitable attenuation factor; and, secondly, a spherical wave varying inversely as the distance. The relative importance of these two types is a function of the wave-length and distance.

The theory further indicates that there are in the daytime three fairly well defined ranges of wave-length, each characterised by a different type of absorption, the transitions from range to range occurring approximately at 40 m. and 4000 m. Short waves less than 40 m. of the cylindrical type, and long waves greater than 4000 m. of the same type, suffer only small absorptions; the waves intermediate between 40 m. and 4000 m. being characterised by large absorption. In this range only, the spherical type of wave is the most important, but here the theory no longer applies, since this type of wave is largely modified by the earth's curvature.

The physical aspect of these effects is fairly obvious, for if the layer were either a perfect metallic conductor or a perfect dielectric with a dielectric constant less than unity, the waves would be transmitted round the earth without loss. On the long waves, where τ is small compared with the time period of the waves, the layer acts as a good metallic conductor; on the other hand, on very short waves the effect of collisional dissipation is very much reduced and the layer acts as an almost perfect dielectric which with ionic loading has an effective dielectric constant less than unity, and consequently bends the rays round the earth with only little loss.

In the intermediate range the loss is a maximum and the absorption is consequently at its greatest.

This should serve in a rough manner to illustrate the numerical results which are shown in the diagram (Fig. 1). The ordinates here represent the logarithm of the intensity, and the abscissæ the logarithm of the frequency; the curves are calculated for transmitters of constant "metre amps."; *i.e.* the product of the current in the aerial and the effective height of the aerial is assumed constant.

The most marked characteristic of this diagram is the drop in intensity in the intermediate range of wave-lengths, and the sudden rise in signal strength on short waves. This illustrates very well the known fact that the absorption on 100 m., say, is so high that transmission over distances greater than about 2000 km. in daylight is impossible, whereas on 30 m., daylight transmission over quite long distances, *i.e.* greater than 10,000 km., has been achieved with only little transmitting power.

On the long-wave range, *i.e.* waves greater than about 5000 m., the agreement with theory is quite close, for a large number of measurements have been made at varying distances from the transmission stations which agree quite definitely with a transmission formula based on the conducting layer theory (G. N. Watson, Proc. Royal Soc., A, vol. 95, July 15, 1919), *i.e.* of the form:

$$E = \frac{120\pi hI}{H\sqrt{\lambda R \sin\theta}} e^{-\alpha d/\sqrt{\lambda}}$$

It would appear, then, that what may be called the Eccles-Larmor theory of refractive bending, and the Watson theory of a conducting layer, are each applicable in their particular range of wave-length; the former for very short waves, and the latter for very long ones.

T. L. ECKERSLEY.
Research Department,
Marconi's Wireless Telegraph Co., Ltd.,
Chelmsford.

Spiral Springs of Quartz.

IN connexion with some work on gravitation, I felt the need of a spiral spring of greater delicacy than is ordinarily met with in the laboratory. With the help of my assistant, Mr. A. Glodenis, I have succeeded in making satisfactory springs of quartz. Our very first effort with an improvised apparatus resulted in a spring of four turns of about two centimetres

diameter, possessing excellent elastic properties. Three one-hundredths of a gram gave an extension of one centimetre—this was indeed a short and powerful spring in comparison with those we succeeded in making later.

The following is the method of manufacture.

A small hole is drilled into the body of a carbon cylinder near one end, a splinter of fused quartz being driven into this hole. Having fixed the cylinder in place as the protruding axle of a mounted wheel, the splinter of quartz is fused to a fixed piece of fused quartz by means of the oxy-acetylene flame. The junction, kept as near to the cylinder as possible, is kept constantly heated, while the carbon cylinder moves uniformly with the motion of an advancing screw.

It is better to split the cylinder into two halves, separating them at the ends by means of two slightly tapering wedges. Having wound a spring, the wedges are carefully extracted and both halves of the cylinder are brought into contact, whereupon the spring can be gently blown on to a thinner glass rod.

Carbon is used because it resists fusion and because it is easier to see the spring on a black background. To avoid impairment of vision, it is advisable to view the fusion of the quartz under coloured glass.

K. Šliupas.

The Physical Laboratory,
The University of Lithuania,
Kaunas, May 4.

I HAVE read the letter on "Spiral Springs of Quartz" by Dr. Šliupas with very great interest, and I should like, if he will allow me to do so, to congratulate him and his assistant, Mr. Glodenis, on their success.

When I was working on quartz fibres in the late 'eighties of the last century I made an attempt in this direction, but an unsuccessful one. This was based on a perfectly successful production of a helical spring made of spun glass, and though I showed that at the time I do not remember describing its mode of production. I turned a slightly tapering iron mandrel about $\frac{3}{16}$ inch (5 mm.) in diameter and mounted it so that it could be turned round with its axis either level or slightly inclined. A length of spun glass was attached near one end of the mandrel with (I think) a spot of shellac varnish. When this was dry a weight was attached to the lower end of the glass fibre. The weight was wound up by turning the mandrel as by a windlass and the other end was similarly fastened. The helix could be wound either close or with any spacing desired by suitable inclination of the axis. The mandrel wrapped with fibre was then buried in fine gunpowder charcoal in a box and heated to fix the form of the helix. At my first attempt I employed a red heat, but the chemical action of the charcoal reduced the lead in the glass and it was no use. Heating another one to some unknown temperature below a red heat completely fixed the form, but in this case the lead was not reduced and a perfect weighing machine was so made. The slight taper facilitated removal of the fibre from the mandrel. I am afraid to say now what small amount was within the limit of observation.

What surprises me about the method of Dr. Šliupas is that he should be able to produce the quartz fibre practically in contact with the carbon cylinder and of useful uniformity. I note that he used acetylene, which I have always feared might have some action on the quartz. For this reason I have never used it or coal gas, only hydrogen. So far as I can remember now I found that a quartz fibre treated in the manner which succeeded with glass had become rotten, and in the light of the reduced lead in the glass I had some misgivings as to the immunity of the quartz, but I did not pursue the matter.

The glass spring made as described above was perfect in its regularity of form. I have some vague recollection that I found that spun glass annealed as described was much more free from "after-working" than raw spun glass, but the perfection of the quartz fibre in this respect caused me to lose interest in the improvement of glass.

C. V. Boys.

Bioluminescence.

RECENTLY I had occasion to make an electrical joint in the dark, and while unrolling the insulating tape I observed along the line of separation a band of green light. The tape in question is manufactured by the County Chemical Company, Ltd., of Birmingham, under the trade name "Chemico." Several other types of adhesive tape that were examined did not exhibit the phenomenon.

As the green colour immediately recalled the appearance of the light emitted by certain living organisms, I have ventured to use the above heading, "Bioluminescence."

When the tape is unrolled slowly in a dark room, a faint band of green light appears. As the speed of unrolling is increased, the intensity of the light becomes greater, but the colour does not change. At moderate speeds the light is remarkably vivid.

Its appearance is not due to any electrical charge which might have been imparted, for example, during the initial winding of the roll. If the unrolled tape is slowly but firmly rewound, the light will again appear when the tape is unwound. Passing the roll repeatedly through a Bunsen flame does not destroy or even appreciably reduce the quantity of light evolved. If the tape is unrolled while totally submerged in cold water, the light appears quite as vivid as in air, but in hot water the intensity is slightly reduced. Similarly, when the tape is heated in air, the intensity appears to be affected, presumably owing to some variation of the viscosity of the adhesive medium.

When the line of separation is examined under the microscope, it will be seen that numerous elastic threads are produced and ruptured in the process of unrolling. It is only when the unrolling is stopped that these threads can be seen, as they cannot readily be distinguished when the green light appears, owing to its intensity.

The energy expended in the actual production of the light is probably very small. It is not to be gauged by the energy required to unroll the tape; the same force may be required to unroll two tapes, one of which emits light whereas the other does not.

There can be little doubt that the phenomenon is one of mechanical luminescence; the sudden extension and possible rupture of the tenacious threads into which the adhesive material is drawn apparently results in the emission of light. The question arises as to whether or not the light occurs during the extension of a thread or at the moment of rupture. If under a low power microscope the tape is unwound so slowly that the extension and rupture of the threads can be observed, it will be seen that the rupture is confined to about one-third of the total length of the threads, including their thickened roots. If now the speed of unrolling is increased until the light appears, it will be seen that the whole of the threads, including the thickened roots, are illuminated.

While it is conceivable that, even if the light were only produced at the moment of rupture, it need not

necessarily be confined to the region of rupture, the evidence seems to be in favour of the luminescence being the result of the sudden extension of the viscous substance.

In view of the uncertainty that exists regarding the source of bioluminescence and the scantiness of the evidence in support of even the oxidation theory, a source of light that so closely resembles that emitted, for example by the glow-worm, must be of interest to zoologists and be worthy of further consideration.

It is suggestive that the contents of the luminous cells are so often described as oily, glutinous, and viscid. Is it not possible, therefore, that these gelatinous cells or their granular contents may be capable of sudden longitudinal extension with the production of light of a bioluminous character?

JAMES WEIR FRENCH.

Anniesland, Glasgow, W.2,
May 11.

Dosage with Ultra-Violet Radiation.

THE beneficial results obtained in the treatment of many diseases by the application of ultra-violet radiations raise the question as to which radiation and what amount is specific to a certain effect. This question is rendered the more difficult of answer by the variety of sources used and the lack of specification of the exact conditions of operation.

The variables affecting the health and vitality of a living subject undergoing treatment are sufficiently numerous in themselves to warrant that the ultra-violet radiation used shall be fixed in its character. Records of treatment and effect (which must now daily be compiled) would be rendered the more valuable if the radiations used could be specified. The more accurate the specification is made, both as to spectral character of the radiation as a whole and as to the energy distribution among the various wave-lengths used, the more rapidly will progress result. At best, measurements of ultra-violet energy are difficult, and it is not hoped or suggested that each person responsible for the administration of ultra-violet radiation would make such energy measurements. Help, however, must be afforded to the general user by those exclusively engaged in the study of ultra-violet radiation by intensive attempts at complete and accurate standardisation of the radiations used and in the development of steady fool-proof sources. Both are problems difficult of accomplishment but not impossible, and must ultimately be solved.

Of the devices used as sources of ultra-violet radiation, constancy in the spectral distribution of energy is not approached by any open arc device. Closer realisation of such constancy is given by the use of quartz-enclosed arcs. Referring particularly to mercury vapour lamps, with due specification of the power input and the conditions of use (ventilation, etc.), approximately constant radiation characteristics are realised. The fulfilment of the requirements of constancy and reproducibility of radiation, to be obtained by the use of an enclosed arc, goes hand in hand with the advantages of the manipulation of a fixed closed unit requiring little or no adjustment.

Apart from the sun and open arcs, there exist but three noteworthy sources of ultra-violet radiation available for therapeutic purposes—the mercury arc, the tungsten arc, and the super-heated tungsten filament—each being enclosed in a fused quartz container. The spectral characters of the radiation obtained from these three sources, however, differ greatly. The continuous spectrum of the tungsten filament may be made to reach 290 $\mu\mu$, but the energy in this region is small. The spectrum of the tungsten arc is closely packed with lines, none of which carry a preponderating share of energy. This spectrum tails rapidly in intensity towards 200 $\mu\mu$. The mercury arc spectrum, on the other hand, which extends well into the deep ultra-violet, has the energy of its ultra-violet radiation concentrated about relatively few wave-lengths.

Despite these great differences in the spectral character of the radiations, no great and fundamental distinction appears so far to have been made between the result obtained in the treatment of disease and in the irradiation of vitamin-deficient food-stuffs by radiation from these various sources.

Is it, therefore, to be concluded that radiation belonging to one (or several) of the intense lines in the mercury arc spectrum is responsible for the beneficial therapeutic results obtained? The question presses for answer. The production of vitamin properties in food-stuffs appears to be a subject peculiarly amenable to exact study; and an examination of the results to be obtained by the ultra-violet irradiation of vitamin-deficient food-stuffs using the different sources in turn and with complete specification of the conditions of their use, would help towards our understanding of the mechanism of the changes which are induced.

H. D. H. DRANE.

Research Dept.,
The Thermal Syndicate, Ltd.,
Wallsend-on-Tyne.

The *K* Absorption Levels of the Light Atoms: A Correction.

IN Roy. Soc. Proc., A, vol. 104, p. 455 (1923), I gave the results of measurements of a number of "soft" X-ray absorption levels. The ν/R values of the levels were deduced from the kinetic energies of the groups of electrons expelled from the atoms by X-rays of known frequency. In most cases the results agreed very well with the values deduced from spectroscopic X-ray data, but fairly wide systematic deviations were observed in the case of the *K* levels of the light atoms—my values being appreciably higher than those previously accepted. In the case of the oxygen *K* level the value of ν/R came out 42·3, which is 4 units—more than 50 volts—greater than Kurth's value of the *K* critical excitation potential for oxygen (Kurth, *Phys. Rev.*, 18, p. 461, 1921).

As was pointed out in the original paper, my method of measurement was not suitable for exact determinations of very "soft" levels: the results in these cases come out as the difference between two large and nearly equal quantities, one of which is deduced from the measurement of a magnetic field and a radius of curvature, while the other is taken from the X-ray spectroscopic tables. Any inaccuracies in the values of the universal constants e, e/m_0, and h would introduce systematic errors into the calculations, the effects of which would be most marked in the case of the levels of lowest energy. Apart from uncertainties of this kind, an error of 1 part in 1000 in the absolute value of the magnetic field would cause an error of nearly 3 per cent. in the value of ν/R deduced for oxygen *K*. I stated, however, at the time that the deviations of my results from the older results were too big to be accounted for by defects in the method or errors in the measurements (*loc. cit.* pp. 478-9). I now wish to correct this statement.

I have recently extended the series of measurements of corpuscular spectra, with new and improved apparatus (work now in course of publication in the

Phil. Mag.). The new measurements of such of the *L*, *M*, and *N* spectra of the heavier atoms as have been repeated agree excellently with my original values (within 1 part in 1000). In recording the spectrum of uranium with a target of uranium oxide, I obtained, however, a line which was clearly due to the oxygen *K* level. This line falls about midway between the uranium N_V and N_{VI} levels, which are fairly widely separated. Measurements on this gave a much lower value for the oxygen *K* level—namely, ν/R 36·7 instead of 42·3—and this led me to re-determine the other values for the light atoms. The revised values are :

Element.	ν/R *K* Level.	Other Values.
20 Calcium	296·6	297·5 F.
16 Sulphur	180·3	181·8 F.
12 Magnesium	93·6	95·8 F.
11 Sodium	76·6	..
8 Oxygen	36·7	35·3 M. 38·3 K.

F. = Fricke, M. = Mohler and Foote, K. = Kurth.

It is clear from the new measurements that in the earlier experiments the Helmholtz coils must have moved. During the work on the heavier elements the magnetic fields were calibrated from time to time and found to remain perfectly constant. The light atoms were tested at the end, just before the apparatus was dismantled, and no re-calibration was made in this case. The new work shows quite clearly that only the measurements on the light atoms were affected by this accident.

H. ROBINSON.

Physical Laboratory,
The University, Edinburgh,
May 27.

Anomalous Dispersion and Multiplet Lines in Spectra.

RECENTLY, H. B. Dorgelo has carried out a series of measurements of the intensities of the components of multiple spectral lines (Dissertation, Utrecht, 1924) and obtained results of great interest. He found that the doublets of the sharp series of the alkalies had a 2 : 1 ratio of intensity, the triplet components of the sharp series of the alkaline earths had a 5 : 3 : 1 ratio, the triplets of the sharp series of a sextet system had a 4 : 3 : 2 ratio, and the triplets of an octet system a 5 : 4 : 3 ratio. The theoretical interpretation of this result has been discussed by Sommerfeld ("Atombau," Fourth Edition, p. 649) and by Ornstein and Burger (*Zeit. für Physik*, 1924, 24, p. 41). As illustrations of Dorgelo's work may be quoted the case of the triplets of manganese 6021, 6016, 6013, which show a 4 : 3 : 2 intensity ratio.

Probably the best known case of the existence of simple intensity relationships of this kind are the two D-lines of sodium, for which a 2 : 1 ratio has long been shown. The anomalous dispersion of sodium vapour has been extensively studied, notably by Roschdestwensky, who found (*Ann. der Physik*, 1912, vol. 39) that of two constants a_1, a_2 in the dispersion equation

$$n = 1 + \frac{a_1\lambda^2}{\lambda^2 - \lambda_1^2} + \frac{a_2\lambda^2}{\lambda^2 - \lambda_2^2},$$

where λ_1 and λ_2 are the wave-lengths of the two D-lines, a_1 was just twice as large as a_2. Dorgelo's work suggests that, in the case of multiplet lines, similar numerical relationships between the constants of anomalous dispersion should be found. Unfortunately, very little in the way of quantitative data on anomalous dispersion is available except in the case of the alkali metals.

Perhaps the best work in this direction is that of A. S. King at Mount Wilson, who with the electric furnace studied the anomalous dispersion of iron, chromium, titanium, and manganese lines (*Astrophysical Journal*, 1917, 45, p. 254). An enlarged photograph of the anomalous dispersion due to the manganese triplet 4031, 4033, and 4035, which belongs to the sextet system, reproduced with King's paper, has been examined, and it is found that the dispersion constants a_1, a_2, and a_3 of the lines deduced from the photograph agree closely with the 4 : 3 : 2 ratio to be expected on theoretical grounds. In the case of the chromium triplets 5208, 5206, and 5204, Dorgelo obtained experimentally an intensity ratio of 100 : 72 : 45, while King's photographs give the ratio of anomalous dispersion to be roughly as 100 : 75 : 50, which is a fair agreement. A careful study of the original negatives secured at Mount Wilson may be suggested as likely to furnish further data regarding these interesting spectral relationships.

C. V. RAMAN.
S. K. DATTA.

A New Standard Solution for Sahli's Hæmometer.

SINCE Sahli's hæmometer has come more and more in practical use for the colorimetrical inspection of human blood, there has been no lack of experiments to obtain a standard liquid which will keep its colour in daylight better than the indicated hæmatine solution. Most experimenters have clung to Sahli's principle, that in quantitative determination of the contents of iron in blood, the standard liquid should be, so far as possible, the same as the blood solution to be examined. This research is limited to the derivatives of hæmoglobin and has not yet produced the desired result, so far as I know.

The cheapness of the instrument being admitted as a main factor, leads to the use of aniline and similar fluids as a standard. These products have not the slightest chemical relation with hæmoglobin ; and they all have the fault that they do not retain colour.

A third standard is the coloured solid glass staff—in fact the combination of Fleischl's and Sahli's hæmometer. Although the colour of the glass seems to last, this standard gives different results, depending upon the kind of light in which the blood determination is made.

I think it advisable to use as a standard a solution of chlorophyll (or related products—the phlobaphenes), namely, an extract of leaves, browned to the darkest tint. It has been proved to be possible to get in this way a solution imitating absolutely the colour of Sahli's standard, having the following advantages :

(1) Chlorophyll is from a biological and chemical point of view more similar to hæmoglobin than any other chemical product (except the hæmoglobin-derivatives). This advantage is only theoretical.

(2) This solution contains a natural brown colour formed by sunlight (or a similar physical process), so that it seems logical to think it impossible that this colour, once isolated, should undergo further change.

(3) This solution is easily made and is cheap.

The simplest way of making this standard solution is as follows :—Tea leaves should be macerated for one hour in an antiformine-water mixture (for example, 1-10). The more tea leaves are taken, the darker the extract becomes. The brown extract so obtained is filtered and the antiformine solution added to it, in a clean glass tube of exactly the same size and kind as Sahli's, until the colour is that of Sahli's standard. The comparison can be made "*à vue*" or with other

colorimetrical methods. The tube is closed by heating the opening, and is now ready for use.

I made a solution for a standard tube one year ago, and although it has been exposed to different kinds of light all the time, it has not changed.

A. K. J. KOUMANS.

University Hospital, Leyden, Holland,
May 5.

Approximations to the Probability Integral.

RECENT numbers of NATURE contain two interesting approximations to the probability integral, one by Prof. H. C. Plummer (October 25, 1924), and one by Mr. S. Krichewsky (January 10, 1925). A comparison made by the latter shows that of the two different formulæ Prof. Plummer's is more accurate for small values of the argument, but breaks down completely for $x/\sigma > \sqrt{6} = 2{\cdot}449$.

In my opinion, however, the most significant point about such approximations, and the one on which their practical usefulness depends, is the integrability of the resulting equation. In stellar statistics, for example, we are constantly dealing with problems involving integration of the incomplete probability function, and an analytical approximation to erf (x) is then invaluable.

I take it that Mr. Krichewsky's formulæ (3) and (5) should read as follows:

$$z = k\left(\frac{a^2}{4} - y^2\right), \quad y = \sqrt{\frac{a^2}{4} - 10^u},$$

giving: $$y = \frac{a}{2}\sqrt{1 - 10^{-0{\cdot}5354\,x^2/2\sigma^2}}.$$

This last expression is not integrable. In fact, it is much more difficult to handle, and much more inconvenient to expand into power series, than the original exponential function or its integral.

Prof. Plummer's formula $\text{erf}\,(x) = \frac{6}{\sqrt{\pi}}\frac{x}{x^2+3}$ is extremely simple, and, when integrated, gives rise to an arc tangent or a logarithm.

Concerning the usefulness of approximations when the *values* only of the probability function are needed, it may be pointed out that Mr. Krichewsky's formula requires a table of logarithms, and even then takes more time than interpolation from a probability table. Prof. Plummer's formula can easily be memorised, and the entire calculation can be done in one's head, in about the same time as it takes to interpolate from a table.

W. J. LUYTEN.

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Cambridge, Mass.

The Word "Australopithecus" and Others.

ALL will admit that many words of Greek origin were used by the Romans, and that *pithecus* was one of them. The evidence adduced, however, does not prove that *pithecus* was regarded as a Latin word. The *pithecium* of Plautus is not a Latin diminutive; it is merely a latinisation of an ordinary Greek diminutive. Had a Roman regarded *pithecus* as Latin, he would not have used the Greek word for "tail" to combine with it: *cercopithecus* is of course pure Greek. Nevertheless had the Roman lived to our day and turned zoologist, he might under stress of circumstances have combined *pithecus* with a word of Latin origin. Circumstances, it is true, did not stress; a good Greek word for "south" was available, and a Roman, especially a "polished Roman," would probably have used it.

But heaven preserve us from pedantry in such matters! The reason for this letter is that Prof. Dart (NATURE, June 6) does not yet realise the many-sidedness of his offences. No Roman, polished or rude, would have used the adjective instead of the substantive. Had Prof. Dart written *Australopithecus* we should merely have shrugged our shoulders and Australia would have had no grievance.

Then "Homosimiidæ"! The word is *not* "parallel with Pithecanthropus or Anthropopithecus," because they are correctly compounded and this is not. But, apart from orthography, if a family is to be erected for the special reception of *Australopithecus*, its name, according to the rules, has to be Australopithecidæ. So that's that.

The moral? Not that a distinguished anatomist must necessarily be a classical scholar; but that any one who sets out to propose a name should realise all his responsibilities. In a word, if you want to join in a game, you must first learn the rules.

F. A. BATHER.

A New Locality for Jurassic Insects.

MR. A. J. LAVRUSHIN, a keen student of geology, who was my interpreter in Siberia, has sent me a careful drawing of a fossil insect which he received from a teacher in the Commercial School at Harbin. It was obtained near the coal mines at Soochan, in the Maritime Province of Siberia. The deposit is known to be Jurassic, probably middle or lower. Mr. Lavrushin says the rock is like that typical of the lower Jurassic. The figure appears to accord perfectly with the larva of the stone-fly *Mesoleuctra gracilis* Brauer, Redtenbacher, and Ganglbauer, known from the Jurassic (supposed middle Jurassic) at Ust Balei, west of Lake Baikal. It seems probable that we have another exposure of these insect-bearing beds, about 1500 miles from the original locality. This, if confirmed, may prove to be a matter of more than ordinary interest. For an account of the Ust Balei deposit and its significance see Bull. Amer. Museum Nat. History, 1924, p. 134.

T. D. A. COCKERELL.

University of Colorado, Boulder,
May 16.

Mercury Helide: A Correction.

IN a former note (NATURE, March 7, p. 337), I stated that a quantitative analysis of mercury helide showed that 210·79 parts by weight of mercury combined with 4·18 parts by weight of helium. I have to regret that this is incorrect. In checking the calculations before incorporating the results in my paper (now ready for publication), I discovered that a decimal point had been misplaced. In consequence of this the stated weight of mercury was ten times greater than that actually found. The simplest assignable formula is therefore $HgHe_{10}$ and not HgHe as at first given.

J. J. MANLEY.

Daubeny Laboratory,
Magdalen College, Oxford, June 4.

Quantum Radiation.

WITH reference to my short letter in NATURE of May 30, p. 838, will you allow me to say apologetically that instead of finishing it off abruptly with the statement that the usual formulæ follow, it would have been better if I had said: "After that no doubt the real difficulties begin." My only object was to direct attention to the peculiarity of the fraction $x/(e^x - 1)$ as almost irresistibly suggesting continuous compound interest growth followed by sudden emission.

ALFRED LODGE.

A New Determination of the Distribution of Stars with respect to Magnitude and Galactic Latitude.

By FREDERICK H. SEARES and Prof. P. J. VAN RHIJN.

THE significance of the numbers of stars visible in different parts of the sky has been recognised since the time of Sir William Herschel, whose star gauges first indicated the flattened, watch-shaped form of the galactic system. The stars having parallaxes which can be measured, either by trigonometric or spectroscopic methods, are all so near that their distances tell nothing of the structural features of the system. These must be learned from counts, like those of Herschel, of stars of different magnitudes in different parts of the sky.

Were the stars all equally luminous, it would be easy to find their distribution in space. Differences in apparent brightness would then be wholly an effect of differences in distance, and star-counts, together with the parallax of a single star, would determine the distances of all objects within reach of our telescopes. Actually, the range in stellar luminosity is enormous, at least 100,000,000 to 1. Differences in luminosity, however, can be allowed for, provided we can find the numbers of stars of different intrinsic brightness in a given volume of space;[1] but this problem has not yet been satisfactorily solved.

Investigations by Kapteyn and van Rhijn indicated that the distribution of luminosity could be represented by a Gaussian error curve, with a maximum frequency for luminosities 0·07 that of the sun. The present authors, however, have independently shown that this maximum is not real and that the frequencies continue to increase probably at least so far as luminosities equal to 0·001 that of the sun. The highly luminous stars, on the other hand, are well represented by the ascending branch of an error curve. Thus at present we have an excellent approximation for the relative numbers of stars intrinsically brighter than the sun, which stands about midway in the known range of luminosity, but only general indications as to the behaviour of fainter stars. This somewhat restricts the immediate usefulness of star-counts but does not lessen their ultimate value.

The star gauges of Sir William Herschel were extended to the southern hemisphere by Sir John Herschel in 1834–38, and the accumulation of star-counts thus begun has been continued by others, in recent years especially by Kapteyn and van Rhijn, whose respective distribution tables are in "Groningen Publications," Nos. 18 and 27. Successive revisions of the data have extended the counts to larger areas of the sky and to lower limits of brightness, and have also improved the scale of magnitudes to which the counts are referred.

The serious practical difficulty lies in the magnitude scale, which must be accurate if the counts are to be useful. The range in apparent brightness covered by large telescopes is 20 magnitudes or more. The establishment of standards over this interval requires the ultimate comparison of light sources the intensities of which are in the ratio of at least 100,000,000 to 1. Under the most favourable conditions, sources of the same order of brightness and of the same colour can be compared with an uncertainty of about 1 per cent.; but as the differences in brightness and spectral composition increase, the uncertainty becomes much larger. Comparable difficulty in the measurement of lengths would mean, for example, an error of several inches in determining the dimensions of a room. An ordinary yardstick does a hundred times better than this, let alone the precise methods of laboratory measurement.

The difficulty of bridging a long interval of brightness by visual methods is illustrated by the scale underlying Kapteyn's table of stellar distribution. This, the best visual scale available up to 1915, is now known to be a magnitude in error at the sixteenth magnitude, the equivalent of 150 per cent. in the light-intensity of the stars to which this magnitude was assigned. Mainly because of this same difficulty the conspicuous increase in the concentration of stars in the Milky Way with increasing magnitude, which was already indicated by the gauges of Sir John Herschel, remained an open question until 1917, when counts of 40,000 stars observed photographically at Mount Wilson put the matter beyond doubt.

The application of photographic methods by Pickering and Miss Leavitt did much to increase the precision, and the resulting Harvard photographic scale, defined by a sequence of stars at the North Pole, is the basis of the distribution table of van Rhijn. Investigations in photographic photometry begun at Mount Wilson in 1910 led to the Polar standards of brightness published by Seares in 1915. These were afterwards strengthened by additional data, and to the sixteenth magnitude have been confirmed at several observatories; below the sixteenth magnitude, however, the Mount Wilson standards are still the only ones available.

These investigations, which comprise the Mount Wilson contribution to the International Scale adopted at Rome in 1922, were preparatory to a study of the distribution of faint stars in the 139 Selected Areas of Kapteyn between the North Pole and declination $-15°$, an undertaking now finished. The individual magnitudes will be published in the "Mount Wilson Catalogue of Selected Areas." The detailed discussion of the counts based on these magnitudes and a revision of certain earlier results will also be published elsewhere. Some matters of general interest, however, may be summarised here.

The new distribution table depends on: (*a*) The Mount Wilson "Catalogue," which completely determines the distribution for stars between magnitudes 13·5 and 18·5; (*b*) Van Rhijn's tables, "Groningen Publication," No. 27, reduced to the international scale by (*a*). These afford results for the interval $m=4·0$ to 9·0 and establish the scale for counts from a third source, (*c*), consisting of 33 zones of the Astrographic Catalogue between declinations $-65°$ and $+62°$. These counts, published by Turner, include about 1,400,000 stars and determine the distribution in the interval $m=9·0$ to 13·5.

The Mount Wilson "Catalogue" (*a*) is based on two partially independent investigations: (a_1) measures

[1] Practically we are obliged to assume that the relative numbers are the same at all distances.

made at Mount Wilson on photographs of 15 minutes exposure or less, which establish the scale and give the magnitudes of 65,683 stars in fields 23′ in diameter; and (a_2) measures at Groningen on Mount Wilson photographs of 60 minutes exposure. These give the magnitudes of 44,910 stars in fields 15′ × 15′ or 20′ × 20′, based on standards derived from (a_1). Most of these stars are included in (a_1), so that the total number of individual objects is approximately 70,400. The magnitudes are on the international scale.

The fields in the 139 Selected Areas cover but 1/2500 of the entire sky. Nevertheless, examination shows that had the alternate areas been discussed separately, the two series of counts would have led to nearly identical results. Individual areas show large deviations from the mean, but with the exception of regions in the Milky Way there is little systematic uncertainty. This perhaps as well as anything illustrates the underlying statistical unity of the stellar system. Properly selected, 1/5000 of the stars between magnitudes 13·5 and 18·5 reveal the main features of the distribution with only a small percentage of error.

The densities derived from the combination and adjustment of data for the three intervals 4·0-9·0, 9·0-13·5, and 13·5-18·5 are so regular that they have been extrapolated to the twenty-first magnitude, which is the practicable limit for long-exposure photographs with the largest telescopes. The table, which thus covers a range of 17 magnitudes, gives the logarithm of the average number of stars per square degree brighter than photographic magnitude m($\log N_m$) situated in different galactic latitudes. Local irregularities, differences between northern and southern latitudes, and systematic deviations in longitude have been ignored for the present. Averages for latitude intervals 0°-20°, 20°-40°, 40°-90°, and for the whole sky are also given. Correction of the magnitude limits for colour leads to average densities for the entire sky for a grouping of stars according to *visual* magnitude. The complete transformation of the table to visual limits cannot be made at present because of lack of data for the variation of mean colour with galactic latitude.

The total number of stars to the twenty-first photographic magnitude is $8{\cdot}9 \times 10^8$, or, to the twentieth visual magnitude, a round 10^9. It is difficult to specify the uncertainty attached to these numbers. There is no means of testing the magnitude scale for the very faint stars; but if the limiting magnitude of the table is correct within one or two tenths, we may consider ourselves fortunate. Since the average change in N_m per magnitude at the limit is about one-half of N_m itself, the uncertainty in the totals from this source alone can scarcely be less than 5 or 10 per cent. Errors in the final counts arising from the choice of regions used as samples, as already stated, must be small, except possibly in low galactic latitudes. The fields in the Milky Way are not numerous, nor are they well distributed in galactic longitude, and the tabular densities are here subject to considerable uncertainty, although the amount cannot be stated.

For bright stars at all points in the sky, the ratio of totals to successive magnitude limits N_{m+1}/N_m is 2·9. With decreasing brightness this ratio falls off, but most rapidly in the direction of the galactic poles. Thus in passing from the twentieth to the twenty-first magnitude the total in the Milky Way is increased 1·8 times, while at the poles the increase is only 1·4 fold. Were the stars uniformly distributed in space, the ratio (excluding losses of light by absorption, scattering, etc.) would be constant and equal to 3·98. The actual ratios therefore show that the stars thin out with increasing distance from the centre; that at great distances they thin out more rapidly than near the sun; and that this thinning out is most pronounced in the direction of the poles of the Milky Way—results obviously related to the flattened, watch-shaped form of the system.

The variation in $\log N_m$ can be used to estimate the probable total of all the luminous stars, both visible and invisible, in any direction, and hence also the total for the system. Earlier data indicated that dN_m/dm could be represented by an error function for practically all values of m to the limit of the counts. It was, therefore, natural to assume that the law also applied to stars too faint for observation, whereupon a simple integration gave the required total. The relation between star-counts and the luminosity and density functions indicates, however, that the values of dN_m/dm for the brighter stars cannot be well represented by an error function, and the present counts confirm this conclusion. Below the twelfth or thirteenth magnitude the representation is excellent, but above this limit the second differences in $\log (dN_m/dm)$ are not constant. This restriction raises a serious question as to whether the error function applies to the invisible stars. For lack of anything better, we assume that it does apply, and thus find: Total number of stars per square degree in galactic latitude 0°, 5,320,000, one-half of which are fainter than magnitude 30·6. For latitude 90° the total is 7160, with one-half fainter than magnitude 23·9. The corresponding totals to $m = 21{\cdot}0$ are 73,600 and 1667 respectively. Hence in the direction of the poles of the Milky Way about one-fourth of the stars between the sun and the limits of the system are accessible to observation. In the direction of the Milky Way the fraction is one-seventieth.

Stars of all magnitudes are most numerous in the Milky Way, but the concentration in the galaxy is obviously much greater for faint than for bright stars. At the fourth magnitude the ratio of the values of N_m for 0° and 90° is 3·5; at the twenty-first magnitude it is 44; to the limits of the system, 743. The importance of the Milky Way as a structural feature of the system is also indicated by the fact that 95 per cent. of all the stars are within 20° of the galactic plane. The remaining two-thirds of the sky contain but 5 per cent., of which less than 1 per cent. is in that third between latitudes 40° and 90°.

Three different methods of summation give values for the total in the system ranging from $3{\cdot}0 \times 10^{10}$ to $3{\cdot}7 \times 10^{10}$, of which the lower limit is the most probable value. This, however, like all other results depending on the assumption that the adopted formulæ for dN_m/dm hold to the limits of the system, is very uncertain. Even at the galactic poles, where a considerable fraction of the stars can be observed, the extrapolation is risky enough; and naturally it is very much more so in the Milky Way, where apparently

less than 2 per cent. of the stars are within observational reach. But whatever the actual total, it is clear that the number of stars beyond the range of the largest telescopes is many times that accessible to observation.

The total amount of starlight is little affected by questions as to the number of stars in the system. For the distribution given above, the stars brighter than the twentieth visual magnitude, comprising but 3 per cent. of the total, contribute 98 per cent. of all the starlight. The integrated visual light for the whole sky is the equivalent of 1076 stars of visual magnitude 1·0 on the international scale. The corresponding numbers found by Yntema and van Rhijn from measures of the brightness of the sky are 1350 and 1440, the unit being referred to the Harvard scale. The outstanding difference corresponds to about 0·3 mag. Since the stars of about the twelfth apparent magnitude contribute the largest amount of light, no reasonable correction to the magnitude scale will wholly account for the difference.

The Expedition of the R.R.S. *Discovery*.

THE Royal Research Ship *Discovery*, which is leaving England at the end of the present month, will be engaged for the next two years in oceanographical investigations in the South Atlantic and Antarctic. The ship, which is barque-rigged with auxiliary steam, was built in 1901 for the late Captain Sir Robert Falcon Scott, and was acquired on behalf of the Falkland Islands Government for the purpose of the present investigations in 1923. During the last eighteen months she has undergone extensive repairs, and changes have been made in her masting and sail-plan in accordance with experience obtained by Capt. Scott. She has been refitted throughout, and is now completely equipped for the investigations for which she is intended.

The cost of the expedition will be met entirely from public revenues raised in the Dependencies of the Falkland Islands, and the work will be controlled, subject to the instruction of the Secretary of State for the Colonies, by an executive committee, constituted as follows: Mr. E. R. Darnley (Colonial Office, chairman); Sir Sidney Harmer (British Museum, vice-chairman); Sir J. Fortescue Flannery, Bt. (consulting naval architect); Mr. H. T. Allen (Colonial Office); Mr. J. O. Borley (Ministry of Agriculture and Fisheries); Capt. J. D. Nares (Admiralty), and Mr. J. M. Wordie (Royal Geographical Society): Mr. H. Horsburgh (technical assistant); Mr. E. W. Baynes (secretary).

The scientific officers of the expedition are: Dr. Stanley Kemp (Director of Research); Messrs. A. C. Hardy, J. E. Hamilton, N. A. Mackintosh, J. E. G. Wheeler, L. H. Matthews, and E. R. Gunther (zoologists); Messrs. H. F. P. Herdman and A. J. Clowes (hydrologists). Messrs. Mackintosh, Wheeler, Matthews, and Clowes are at present serving at the shore station, South Georgia. The marine staff includes: Commander J. R. Stenhouse (captain); Lieut.-Commander W. H. O'Connor (chief officer); Lieut.-Commander J. M. Chaplin (second officer and surveyor); Eng.-Lieut. W. A. Horton (chief engineer), and Lieut.-Colonel E. H. Marshall (surgeon).

The principal object of the expedition is to obtain information bearing on whales, more especially on those species which form the basis of the industry now flourishing at South Georgia and in the South Shetlands. Although the whale fisheries in these places are controlled by Government regulations, very little is known of the habits and migrations of the animals and of the reasons for the fluctuation in their abundance. It is, indeed, not yet certain whether the closely similar Arctic and Antarctic whales are specifically identical. There is, therefore, much information to be acquired before a satisfactory basis for the control of the industry can be found.

In connexion with the investigations, a laboratory has been established in Cumberland Bay, South Georgia, where examination is being made of the whales captured at the adjacent whaling station. At this laboratory good progress has already been made, for, although the building was only completed in February, 181 whales had been examined by April 10.

Work on the *Discovery* will mainly be directed towards obtaining information on oceanographic conditions in the waters frequented by southern whales, and routine observations on the hydrography and plankton will be made throughout the voyage. On the whale feeding-grounds intensive work will be undertaken and a close study made of the euphausians, which occur seasonally in great abundance, and constitute the principal, if not the only food of southern rorquals. Plankton nets will be employed at all depths, the smaller hauled vertically and the larger, up to a diameter of 4½ metres, horizontally. New apparatus for opening and closing horizontal nets will be tried, together with a mechanism designed to allow of a number of vertical nets being operated on a single line. A very large midwater trawl, with three otter boards, 250 feet in length and with a mouth area of about 1500 square feet, will be used in an attempt to obtain large pelagic organisms, particularly cephalopods, which would be able to avoid smaller nets. Depth recorders, of pressure gauge and thermometer types, will be used to check the depths at which towed nets are fishing. For work on the bottom the ship is provided with dredges of various kinds, traps similar to those designed by the Prince of Monaco, the Petersen grab, and both beam and otter trawls, but the latter will ordinarily be used only on the coastal banks where fish in commercial quantities are likely to be found.

The deck equipment for biological and hydrographic work comprises a large trawling winch carrying 5000 fathoms of tapered warp on one reel and 1000 fathoms of trawl warp on the other. An auxiliary reel with 3500 fathoms of 6 mm. wire is driven from this winch. For vertical nets and hydrographic appliances there are four smaller reels, driven by three engines and all fitted with 4 mm. wire. Two of these reels carry 3500 fathoms of wire for deep observations and two carry 500 fathoms for observations at lesser depths. A Lucas sounding-machine is installed with various attachments for the collection of bottom samples, and a dynamometer, accumulators, metre recorders, an electric centrifuge, and other subsidiary apparatus are provided. There are two laboratories on the ship, one on the upper and one on the main deck, completely equipped for biological and hydrographic work.

Adequate photographic apparatus and a dark room are provided.

The ship is well supplied with apparatus for taking observations while under way. Two sets of echo-sounding gear, for shallow and deep water, have kindly been lent by the Admiralty, and a distance thermograph, designed to give a continuous record of surface temperature, has been fitted. The Knudsen full-speed water-bottle will provide water-samples at some distance below the surface, and it is hoped that a new piece of apparatus, designed by Mr. A. C. Hardy, will furnish a continuous record of the more important organisms in the plankton.

The *Discovery* is not equipped with harpoon guns of the commercial type, but will carry smaller patterns, with which it is expected that Cetacea up to 25 feet in length can be obtained. Observations on living whales will be made whenever possible, and it is hoped that valuable information on their migrations will result from marking experiments. The form of mark has been adopted after repeated tests on the shooting-range with a target made of whale blubber, and after practice on living whales made by Prof. Hjort and a member of the *Discovery* staff who accompanied him. The mark is similar in form to a large drawing-pin, with three barbs on the shank, and is made of annealed cast-iron and silver-plated. The pin is 2½ inches in length and the disc nearly 2 inches in breadth, with a number stamped on it, together with an inscription offering a reward for return to the Colonial Office. Posters and leaflets are being circulated to all the whaling stations of the world giving instructions for the return of the marks, together with the required information. The mark is placed on the end of a light wooden shaft, and is fired from an ordinary 12-bore gun. With this apparatus good practice has been made at ranges up to 70 yards, and the marks embed themselves well even with the target at an oblique angle. The pin is not long enough to penetrate the blubber, and the operation of marking is thought to be quite painless. It is feared that the *Discovery* may be too slow and unhandy to mark whales in any considerable number, but whale-marking will form a large part of the work of a small auxiliary vessel, of high speed and built on the lines of a whale-catcher, which is now under construction.

Geographical exploration is not included in the programme of the expedition, but it is hoped that the echo-sounding gear will provide valuable data in Antarctic waters, and every effort will be made to improve our knowledge of the coast-line and to survey harbours frequented by the whaling community. The second officer of the ship is a qualified surveyor, whose services have been lent by the Admiralty.

Work will begin in the Gulf of Guinea, which is thought to be the northern limit of migration of southern whales. Observations will be made on the plankton and hydrography of this region, and the whaling stations on the West African coast will be visited. After touching at Cape Town a course will be laid for South Georgia *via* Tristan da Cunha and the Falkland Islands. On reaching South Georgia a close survey will be made of the whaling grounds, and, as at present arranged, in January 1926 the ship will make a passage to the South Shetlands by way of the South Sandwich group, proceeding still farther south to the Neumayr Channel if ice conditions are favourable. In March a return will be made to South Georgia, a line of stations being made between Graham Land and Cape Horn if weather permits. A fresh survey of the whaling grounds is then contemplated, and later in the year, during the Antarctic winter, the ship will possibly return to the African coast. Operations in the second year will depend largely upon the results obtained during the first.

Obituary.

M. CAMILLE FLAMMARION.

THE death of Camille Flammarion at the age of eighty-three years removes from the world of astronomy one of its greatest ornaments, and one of the most picturesque figures in French scientific circles generally. It is difficult to contemplate astronomy in France without the guiding hand of its beloved "maître," whose "élèves" are counted in all branches of society in all lands.

Camille Flammarion might be described as the apostle of popular astronomy. His numerous literary works had for object primarily the popularisation of astronomical study in all its manifold branches, and it is upon the record of success achieved by those works that his reputation as a scientist should stand or fall. Throughout his life this was a passion with him, kept constantly in view, and meeting with extraordinary success in the birth of the Société Astronomique de France in 1887. This notable Society, recognised by the Republic ten years later as being of public utility, now comprises thousands of members of all nationalities, united by a common love of the sky.

Flammarion was not content to spread abroad the gospel of astronomy by book and pamphlet. He believed in the practical application of his theories for the spread of a universal knowledge of the sky. Although he was not openly impatient of the restraint imposed on the professional astronomer by the routine of the national observatories, which exist chiefly for the many problems involved in the determination of time and position, it is common knowledge that this branch of astronomy appealed to him very little. His interest lay principally in the discussion of the physical facts observed through the telescope, a much more picturesque branch of the science. He was frankly proud of the scientific independence of his observatory at Juvisy and its freedom from official restraints and controls.

With most modern observatories nowadays devoting special attention to the study of the physical and vital constitution of the celestial bodies, astrophysics has definitely taken its place alongside mathematical astronomy, and it is not going too far to claim that this extension of activity is due in large measure to the demand which arose from the interest created by Flammarion in his efforts towards what the French call the "vulgarisation" of astronomy.

In the year 1882 an unknown admirer, M. Méret,

conveyed to Flammarion, *regium donum*, the beautiful estate and chateau at Juvisy, a few miles south of Paris, where he has since made his home. Here he installed and equipped a magnificent astronomical observatory, to which in later years he added a meteorological and climatological station which is under partial subvention from the French Ministry of Agriculture,—the only climatological station in France, as Flammarion himself boasted, established in direct connexion with the physical study of the sun.

At Juvisy, in the most charming surroundings, the weather is studied in extraordinarily minute detail. The astronomical observatory is thrown open to the eager student of the sky, and competent amateur observers are encouraged to undertake serious observational study there,—perfect instrumental equipment combining very happily with a perfect position, deep in the wooded country and yet within sight of Paris, whose upstanding wonders, the Eiffel Tower and the domes of Les Invalides and the Panthéon, are visible from the observatory terrace.

It was my privilege to visit M. and Mme. Flammarion at Juvisy in the summer of 1914, just before the outbreak of War, and the memory of that experience will not readily be effaced. Conversationally, M. Flammarion was a man of few words, a characteristic not uncommon among very prolific and highly imaginative writers. During a conference of French-speaking astronomical societies which lasted three whole days he rarely joined in the debates, notwithstanding that the subjects discussed were nearest his heart, and that none was present better qualified to deal with them. Once in Flammarion's presence it was obvious that there must be no bandying of empty compliments ; no presumption upon a short acquaintance ; no departure from the utmost gravity ; no congratulations upon good fortune, be they ever so sincere and free from envy.

It must have been a strange scene as the leonine Flammarion, gravid with thought, conducted us round his beautiful and artistic home ; through the inscribed monumental gateway opening out of the seventh of the great national roads of France; along corridors with the names of great astronomers and philosophers in ornamental writing on the friezes, and into rooms with the signs of the zodiac and other literary and scientific emblems brilliantly emblazoned on the ceilings or carved on the fitments ; introducing us unostentatiously to his treasures with a minimum of words and much less than the usual amount of gesture. Probably to another visitor silence might have been more impressive than actual words, but to me, familiar with that brilliant literary style and fecund imagination which never failed in any of his works, Flammarion's grave taciturnity and his deceptive air of languid indifference were distinctly disappointing, offering great contrast to the eager vivacity of Mme. Flammarion. Subsequent private correspondence with Flammarion has demonstrated the imperfect justice of those impressions, revealing a warm and sympathetic nature which a brief acquaintance refused to discover in him personally.

Whilst Flammarion was a man of many activities, the facts of his astronomical life are few and simple. Born in 1842, his first acquaintance with astronomy dated back to the annular eclipse of the sun on October 9, 1847. At fifteen years of age he was apprenticed to an engraver, and a year later wrote a MS. of 500 pages entitled " Cosmologie universelle," from which later emerged his " World before the Creation of Man." In 1858 he entered the Paris Observatory as a computer, but found under the austere rule of the great Le Verrier little play for his fertile imagination. Leaving the Observatory in 1862, he was immediately welcomed by the Bureau des Longitudes, where he was engaged for three years, presumably in computing work. At the age of twenty-one we find him editing the scientific review *Cosmos*, and in 1864 he commenced the publication of his " Annuaire astronomique," an almanac and astronomical review of unique type, which has now appeared regularly for sixty years. In 1867, Flammarion was recalled to the Paris Observatory by Le Verrier, and placed in charge of one of the largest telescopes for the measurement of double stars. In 1887, Flammarion's review *L'Astronomie* became merged in the monthly bulletin of the Société Astronomique de France, and it is only a few years ago that the original name was restored.

In June 1922, Flammarion's eightieth birthday was commemorated by an immense meeting of his admirers in the great hall of the Sorbonne, Prince Bonaparte presiding in the presence of M. Painlevé. Shortly afterwards Flammarion received one of the greatest honours France has to bestow on a living subject : a commandership of the Legion of Honour.

WILLIAM PORTHOUSE.

THE death on May 26 of Lieut.-Commander Henry Edward O'Neill, R.N., removes one of the last survivors of the pioneer explorers of tropical Africa. Born in 1848, he entered the Navy in 1862 and first saw service in the operations for the suppression of the slave trade on the east coast of Africa. Soon after his appointment in 1879 as British Consul at Mozambique, O'Neill began a series of important explorations between the coast and Lake Nyassa and in the valley of the Shiré river. In five years he completed more than a dozen important journeys and discovered Lakes Amaramba and Chiuta and a new route from Blantyre to the coast. His careful observations of the position of Blantyre made it for long the best fixed position in that part of Africa. In 1885 he was awarded the Patron's medal of the Royal Geographical Society. He was associated with Captain (now Sir Frederick) Lugard in his early work against the slave raiders, and in 1888 distinguished himself in the defence of Karonga, on Lake Nyassa. On his health giving way he was compelled to leave Africa. For a time he was consul at Leghorn and at Rouen, and he retired from the service in 1899. His publications were mainly in the Proceedings of the Royal Geographical Society.

WE regret to announce the following deaths :

Mr. T. S. Brandegee, honorary curator of the herbarium of the University of California, on April 7, aged eighty-two years.

Prof. Heinrich Müller-Breslau, professor of statics and building construction at the Technical High School of Charlottenburg—Berlin since 1888, and a fellow of the Berlin Academy of Sciences, on April 23, aged seventy-three years.

Current Topics and Events.

AT the invitation of Mr. L. S. Amery, Secretary of State for the Colonies, a number of scientific men and others interested in scientific exploration visited H.M. Dockyard, Portsmouth, on Saturday last to inspect the Royal Research Ship *Discovery*, on the occasion of the commissioning of the ship for employment in scientific research in south polar regions. The visitors were taken from London by special train direct to the South Railway Jetty in the Dockyard, where the *Discovery* is berthed. Much interest was shown in the scientific equipment of the ship and in the laboratory and other accommodation. Shortly after noon, Mrs. Amery hoisted the blue ensign of the Falkland Islands, to show that the *Discovery* had been commissioned, and simultaneously the expedition flag was run up. After the ceremony, the party adjourned to Portsmouth Town Hall, where luncheon was provided. Mr. Amery, who presided, in proposing the toast of "The *Discovery* Expedition," referred to the steps taken by the Colonial Office to mark off a zone in the Antarctic as definitely under British control, in order to preserve whales in those waters. New Zealand has also established control over a corresponding section in the Ross Sea. The work to be carried out during the expedition is outlined in an article which appears elsewhere in this issue. Every arrangement seems to have been made to ensure the comfort of the members of the expedition and facilitate scientific investigation in many fields. We believe that this is the first time that a vessel has been described as a "Royal Research Ship," and we hope that it may be followed in due course by other vessels similarly equipped for oceanographic investigations. We cannot be otherwise than grateful that the conditions under which work will be carried on in the *Discovery* are so different from those afforded to Huxley when he went to Australian waters in the *Rattlesnake* nearly eighty years ago.

IN his discourse at the Royal Institution, on Friday June 12, on Faraday as a chemist, Sir William Pope reminded his hearers that Faraday devoted his life to experimental research in chemistry and physics in the Royal Institution, and, at his death in 1867, he was mourned as one of the greatest natural philosophers of the early part of the nineteenth century. Faraday made his advent as a scientific investigator at a moment when striking advances in chemistry were imminent and were indeed to be foreseen; the work of his immediate predecessors, Lavoisier, Davy, Dalton, Berzelius, and Avogadro, had made of chemistry an exact science, and such a genius as Faraday was needed for the development of experimental methods. He worked on a variety of chemical subjects for several years, and on June 16, 1825, laid before the Royal Society the results of his study of the liquid deposited from compressed oil gas, in the course of which he had discovered the compound of carbon and hydrogen now known as benzene. At this centenary of his discovery we celebrate the anniversary of the initiation of a large branch of organic chemistry which in later years became of great scientific importance and, in addition, became the foundation of the several vast industries. Among these latter are to be numbered not only the manufacture of coal-tar dyes but also important sections of the pharmaceutical, photographic, and petroleum industries. Faraday was the first to make a quantitative study of the chemical changes which result from electrical action, and discovered certain electrochemical laws which are of profound chemical significance. He also carried on numerous investigations on optical glass, steel alloys, the transparency of very thin sheets of gold, and the so-called colloidal solutions of metallic gold in water.

ON June 16, the centenary of Faraday's discovery of benzene was celebrated at a full gathering in the historic lecture-theatre of the Royal Institution. His Grace the Duke of Northumberland presided, and in his opening remarks directed the attention of the rising generation to the motives which had inspired Faraday's life, to his profound trust in facts of observation and to his scientific use of the imagination. Although manufacturers have come to recognise the value of such work as Faraday's, in government circles there is still failure to link up scientific methods and discoveries with the public service. His Grace then presented diplomas of honorary membership of the Royal Institution to Prof. E. Bertrand (Paris), Prof. E. Cohen (Utrecht), Prince Ginori-Conti (Italy) (through his representative Dr. G. A. Nasini), Prof. J. F. Norris (Boston), and Prof. G. Sakurai (through Prof. M. Katayama), who were introduced individually by Sir Arthur Keith, secretary of the Institution. Appreciations of Faraday's work were delivered by Prof. H. E. Armstrong, who dealt mainly with the organic chemical aspect, and Prof. Ernst Cohen, who spoke as a physical chemist. Prof. Armstrong stated that the committee organising the celebration had decided to award at intervals—perhaps sexennially—a medal for conspicuous achievement having some relation to Faraday's discovery of benzene. The first award would be made to Mr. James Morton, of Grangemouth, for distinguished work in connexion with the manufacture and applications of anthracene dyestuffs.

FOREIGN delegates of scientific societies were then received by the president of the Royal Institution, the list (a long one) including Prof. E. Bertrand, who read an address, and M. Paul Kestner (France), Profs. J. F. Norris and E. Bartow, Dr. Trowbridge (U.S.A.), Prof. F. Swarts (Belgium), Profs. von Romburgh and E. Cohen (Holland), Dr. Schedler (Switzerland), Prof. M. Katayama (Japan), Dr. G. A. Nasini (Italy). An address was also received from Finland, and Sir William Pope represented the federated chemical societies of Spain. The home societies sending representatives and addresses were the Royal Society (Prof. J. F. Thorpe), Chemical Society (Sir William Pope), Society of Chemical Industry (Mr. W. J. U. Woolcock), Association of British Chemical Manufacturers (Mr. J. Milne Watson), Society of Dyers and Colourists (Mr. E. Hickson),

Faraday Society (Prof. F. G. Donnan). Congratulatory messages were received from the Institute of Chemistry, Indian Chemical Society, various South African societies, Australian Chemical Institute, and (the youngest society) the Auckland Chemical Society. In conclusion, Lord Balfour paid an eloquent tribute to the memory of Faraday, praising in particular his theoretical views on the constitution of the material universe, and expressing his conviction that work of the kind done by Faraday is of far greater value to humanity than the transient labours of the politician. In conclusion, His Grace the Duke of Newcastle thanked the delegates for their presence and for the addresses presented, and Prof. H. E. Armstrong for his work as chairman of the organising committee.

REPLYING in the House of Commons on June 10 to a question as to large scale schemes for eliminating tsetse-flies from British possessions in Africa, Mr. Ormsby-Gore, Under-Secretary of State for the Colonies, drew a necessary distinction between two different proposals. While both schemes are directed towards the early removal of the menace of trypanosomiasis, now overshadowing vast areas of tropical Africa, they are different in scope. To the contemplated international scientific expedition to Uganda, recommended by the International Conference on Sleeping Sickness, held in London last month under the auspices of the League of Nations, we hope to return at an early date. The other project is in no way connected with the League of Nations, but owes much to the energy and enthusiasm of Mr. Ormsby-Gore himself, as shown by the recent Report of the East African Commission, which, under his leadership, visited the British East African Dependencies in the autumn of last year. Briefly stated, what is proposed is to stimulate public interest, and hasten the control of sleeping sickness, and the no less important *nagana* of domestic animals, by speeding up and reinforcing existing methods of attacking the tsetse-fly carriers of these diseases. To this end, it is hoped that it may prove possible to arrange for the appointment of a commission of experts, which shall proceed to tropical Africa for the purpose of undertaking (*a*) complete surveys of all tsetse areas; (*b*) further research into the bionomics of tsetse, including the factors controlling increase or decrease; and (*c*) experiments on a field scale in exterminating these flies. Provided that, pending the issue of the findings of such a commission, the work of which must necessarily be protracted, local governments continue to press forward existing methods of attack, the scheme merits cordial welcome and support.

THE subject of tsetse-fly control received further attention at a meeting of the second Imperial Entomological Conference, held in the rooms of the Geological Society, Burlington House, on the morning of June 15, when the chair was taken appropriately by Mr. Ormsby-Gore. On this occasion a valuable paper entitled "Co-ordination of Effort in Tsetse-fly Investigations" was read by Prof. Warrington Yorke, of the Liverpool School of Tropical Medicine, whose position as one of the foremost authorities on sleeping sickness is universally recognised. Prof. Yorke appealed for organisation to ensure continuity and co-ordination of work, and gave details of an interesting experiment in game exclusion, with reference to its effect upon the local tsetse-fly, *Glossina tachinoides*, now being conducted by Dr. Ll. Lloyd in a small area in Northern Nigeria. In the subsequent discussion, which was both interesting and animated, a number of leading workers on the subject took part, including Dr. Andrew Balfour, Dr. A. G. Bagshawe, Prof. Robert Newstead, Dr. Guy Marshall, Major E. E. Austen, Mr. C. F. M. Swynnerton, Mr. D. W. Scotland, and the chairman.

SIR RAY LANKESTER and Dr. J. W. L. Glaisher were both elected into the Royal Society on the same day, namely, June 3, 1875, so that they have both completed fifty years of fellowship. We understand that the council of the Royal Society has offered congratulations to each of them on their long association with the Society. They are the two senior fellows of the Society next to Sir W. Boyd Dawkins, who was elected in 1867. Sir Ray Lankester received the Copley Medal in 1913, and it is a curious coincidence that in the same year the Sylvester Medal was given to Dr. Glaisher, and hence zoology and mathematics were again through this circumstance in couple. Moreover, they were both at St. Paul's School together. At the time of their respective elections Sir Ray was a fellow and lecturer of Exeter College, Oxford, while Dr. Glaisher was an assistant tutor and examiner in Trinity College, Cambridge. Apart from Sir Ray Lankester's special scientific researches, and not least, those researches which he has inspired in others, and of which he has witnessed the fruition, he has the brilliant gift of literary expression, and has used it to supply the so-called "man in the street" with highly instructive and informative popular descriptions of natural objects and phenomena without loss of scientific dignity. He never, indeed, pandered to the purveyor of "marvels." We may recall that Sir Ray was Director of the Natural History Departments of the British Museum, 1898–1908. He is a corresponding member of the Paris Academy of Sciences, of the Reale Accademia dei Lincei, Rome, and of the U.S. National Academy of Sciences. Dr. Glaisher is a fellow of Trinity College, Cambridge. In his own department of pure mathematics he has done work of supreme value.

THE announcement has been made by foreign correspondents of the daily papers that Prof. Walther Nernst is reported to have communicated to the Berlin Academy of Sciences an account of the discovery of two new elements. It is stated that the new elements have been detected chemically and spectroscopically in several minerals and notably in platinum ores, and that their atomic numbers are 43 and 75. They have been named "masurium" and "rhenium," after the names of the East Prussian borderland and the Rhine respectively. At the time of writing, no details of the methods employed are available and it is impossible to assess the value or importance of the discovery. The new elements

would fall in Group VII. of the Periodic Classification and in a family of which only one member, manganese, has hitherto been known.

THOUGH there were railways long before the Stockton and Darlington Railway and many locomotives before Stephenson's *Locomotion*, the Stockton and Darlington was the first public line and the *Locomotion* the first passenger engine. Newcomen's steam engine owed its birth to the demand of the mines for an efficient pump, and it was in the mines the railway and the locomotive were first developed. The Darlington to Stockton line as originally projected by Edward Pease in 1817 was chiefly for the conveyance of coal to the sea-board, and it was due to the advice of George Stephenson in 1823 that powers were obtained for carrying passengers. This pioneer line was opened in September 27, 1825, when Stephenson's famous engine *Locomotion*, driven by Stephenson himself, drew a train of 34 vehicles with 450 passengers from Darlington to Stockton. Thus was inaugurated the tremendous passenger traffic of to-day. The centenary of this event is being celebrated on an appropriate scale, and on July 1 the Duke of York is opening an exhibition at Darlington. On the following day, *Locomotion* will again be put under steam and will haul a replica of the original train along the line. There is also to be a procession of rolling stock. The celebration has been advanced from September to July on account of the meeting in London during the last week in June of the International Railway Congress. Some 800 delegates representing the railways of the world are attending the Congress, and after the various meetings in London and the district the delegates will proceed to Darlington, when the procession of old and modern locomotives and rolling stock will be repeated. The members of the Institution of Mechanical Engineers will also take a part in the celebration. Stephenson was the first president of the Institution, and the summer meeting is therefore to be held at Newcastle while the centenary celebrations are in progress.

IN the colonial possessions of Great Britain and France the same problems of malaria and sleeping sickness are encountered. British workers are well acquainted with the conditions in their own colonies, but often little is known of those which prevail in the colonies of our neighbours. The two lectures delivered by Prof. Émile Brumpt, of the Faculty of Medicine of Paris, on behalf of the Chadwick Trust, have afforded to medical men in England an opportunity of hearing the views of a distinguished Frenchman on the question of prophylaxis against these two diseases. As was to be expected, the plans of a campaign as outlined by Prof. Brumpt are the same in whatever country it is undertaken, but the instructive series of lantern slides, the outcome of recent tours made by him, illustrated the conditions which conduce to the spread and persistence of malaria and sleeping sickness in countries which rarely come into the experience of British workers. In this respect the lectures were of value in showing that, though the fundamental principles of prophylaxis are always the same, they have to be applied with due regard to the local features of the country and the habits of the natives. Not only is it necessary for the medical officer to have a good knowledge of the diseases themselves and the parasites which cause them, but he must also understand the bionomics of the insect vectors, which vary with the localities to be dealt with, and, above all, he must be able to modify, extend, and adapt the measures to meet ever-varying contingencies. It results that a sound training in the methods of prophylaxis in all its aspects is a *sine qua non* of success. Furthermore, the control of these diseases is an undertaking which must be made by all the colonising nations working to the same end. Progress made in one colony would be very largely frustrated if the diseases were allowed to run riot in an adjoining territory. In this direction of co-operative endeavour the Health Section of the League of Nations has undertaken the arrangement of an international commission to investigate certain problems connected with the spread of sleeping sickness in Africa, with the view of furnishing information which will be of value to all those nations which are attempting to stamp out the disease.

A BRILLIANT spell of fine summer weather has occurred generally over England, and in the southern and midland districts some unusually high temperatures for June have been experienced. The burst of heat set in on Wednesday, June 3, with a shade reading of 73° at Greenwich and a temperature above 150° in the sun's rays. On Saturday, June 6, the shade temperature was 84°, and the mean temperature for the 24 hours was 11° in excess of the normal. The highest temperature in London at the time of writing was on Thursday, June 11, when 87° was registered at Greenwich, which, however, was beaten for the corresponding day by 2° in 1900, when 89° was registered. A temperature of 90° was registered at Greenwich on May 22 and 24, 1922, which is the highest temperature on record to June 15 since 1841. During the 84 years from 1841–1924, the absolute maximum temperature for the several days in June has occurred on 55 per cent. of the days in the 28 years 1841–68, on 20 per cent. in the 28 years 1869–96, and on 25 per cent. in the 28 years 1897–1924. To Saturday or Sunday, June 13 or 14, there were at several places in the south of England 14 consecutive days without rain, which constitutes a drought. Brilliant sunshine was an exceptional feature in the southern and midland districts.

THE recently issued report of the Empire Cotton Growing Corporation for the year ending on March 31 still shows an excess of income over expenditure, but one which is being steadily diminished, as that body is gradually, through its training of men at the universities and elsewhere, overcoming the great difficulty of providing officers with the necessary technical training to assist in the development of cotton overseas. Nineteen men have now been trained, of whom all but two have received appointments. For the present year, as for last, an unlimited number of studentships is offered to those

who are thoroughly qualified. A grant of 3000*l.* a year is being made to assist in the maintenance of experimental farms in Australia, a plant breeder has been sent to Southern Rhodesia, and another to the Sudan, while, in conjunction with other bodies, funds have been provided for the erection of ginneries in Southern Rhodesia. Many other lines of work are also being commenced. At the present time the production of good cotton within the British Empire is progressing steadily, and is expected to reach 350,000 bales in the coming season. There is no sign yet that the top of the curve is in sight, but much sustained and careful work along scientific lines will be necessary to maintain this development, and to carry it to the point of imperial independence in cotton supply.

AT a meeting on June 9, the Illuminating Engineering Society, in co-operation with other bodies interested, held a discussion on "Natural and Artificial Sunlight in Health and Disease." Dr. Saleeby, who opened the discussion, gave an excellent review of this problem, which interests engineers, architects, and medical men alike. There were on view a great variety of special lamps devised to furnish "artificial sunlight." As one of the speakers pointed out, this description is not quite accurate. Nevertheless there is no reason to doubt that such lamps can supplement natural sunlight, with very good results, in medical treatment. Although there has been remarkable gain in our knowledge of effects of light on the human body during recent years, there is much in connexion with the ultra-violet rays, their merits and limitations, that is still obscure. Therefore the view expressed at the meeting that this is essentially a scientific problem, and that such forms of energy should not be applied indiscriminately nor regarded as a panacea for all ills, deserves emphasis. About the general value of sunlight in relation to health there can be little doubt, and every encouragement should be given to efforts to free the atmosphere of our cities from the pollution of smoke from wasteful coal fires. The meeting was a very representative one, and the Society has done good service in bringing together those interested in various aspects of the subject.

THE Council of the British Cast Iron Research Association has recently extended its research programme by arranging for an investigation on the influence of silicon, manganese, and phosphorus on the formation of graphite in cast iron, to be conducted by Mr. M. L. Becker at the University of Manchester, under the supervision of Prof. F. C. Thompson, and for an investigation to be commenced at the National Physical Laboratory, under the supervision of Dr. W. Rosenhain, on the alloy systems iron-silicon, iron-manganese, iron-phosphorus in the presence of carbon over the range usually associated with cast iron. It is anticipated that these fundamental investigations will yield information of great value in connexion with other investigations in hand. The Director and Consultant of the Association are now visiting Continental laboratories and works for the purpose of examining recent foundry developments, particularly in Germany.

AT the anniversary meeting of the Linnean Society on May 26, the Society's Linnean medal in gold, its highest award, was presented to Prof. Francis Wall Oliver, professor of botany in the University of London at University College since 1888, when he succeeded his father, Daniel Oliver, in the chair. In presenting the Medal, reference was made to Prof. Oliver's distinguished services,—his work on the fossil Pteridosperms; on the survey of British vegetation, which resulted later in the establishment of the British Ecological Society; his early observations on tidal problems of vegetation at the Bouche d'Erquy in Brittany, followed by the permanent station at Blakeney Point in Norfolk, now the property of the National Trust, under the conditions of the natural flora and fauna being preserved. The Medal has been given in alternate years to a botanist and a zoologist since its institution in 1888, when the centenary of the Society was celebrated.

A CLIMATOLOGICAL congress, arranged by the Davos Institute for Alpine Physiology and Tuberculosis Research, will be held at Davos on August 17-22. Full particulars can be had from the Institute.

AT the anniversary meeting of the Linnean Society the following officers were elected:—*President*, Dr. A. B. Rendle; *Treasurer*, Mr. H. W. Monckton; *Secretaries*, Dr. B. Daydon Jackson (General), Dr. W. T. Calman (Zoology), and Mr. J. Ramsbottom (Botany).

DR. E. F. ARMSTRONG, of the British Dyestuffs Corporation, Ltd., and Mr. H. Sutcliffe Smith, of the Bradford Dyers' Association, have been appointed members of the Dyestuffs Industry Development Committee set up under subsection 2 (6) of the Dyestuffs (Import Regulation) Act, 1920, in succession to Sir William Alexander and Mr. G. Douglas, resigned.

AT the annual general meeting of the Royal Geographical Society on June 15, the following officers for the ensuing year were elected:—*President*, Dr. D. G. Hogarth; *Vice-Presidents*, Sir Charles Close, Prof. J. Norman Collie, Maj.-Gen. Lord Edward Gleichen, Sir Sidney Harmer, Sir John Scott Keltie, Sir Francis Younghusband; *Treasurer*, Lord Biddulph; *Trustees*, Mr. Douglas W. Freshfield, Lord Ronaldshay; *Hon. Secretaries*, Mr. A. P. Maudslay, Col.-Com. E. M. Jack; *Foreign Secretary*, Sir Maurice E. de Bunsen.

ON Friday, June 26, Viscount Grey of Fallodon will make a presentation to Dr. G. Claridge Druce on behalf of the Botanical Society and Exchange Club of the British Isles, at Dorchester House, Park Lane, London, which has kindly been lent by Sir George and Lady Holford. Particulars of the meeting can be obtained from the Hon. Mrs. Adeane, 1 Dean Trench Street, Westminster.

THE fourteenth International Geological Congress is to be held in Madrid during May and June 1926. The provisional list of subjects for general discussion includes the following topics: The world's reserves of phosphates and pyrites, geology of the Mediterranean and of Africa, Cambrian and Silurian faunas, Tertiary vertebrates and foraminifera, Hercynian

folds, modern theories of metallogeny, vulcanism, and the application of geophysical studies to geology. Excursions covering a wide range of interests are being arranged. The general secretary for the Congress is Señor E. Dupuy de Lôme, Geological Institute of Spain, Plaza de los Mostenses 2, Madrid.

THE Albert Medal of the Royal Society of Arts for the current year has been awarded by the Council, with the approval of the president, H.R.H. the Duke of Connaught, to Lieut.-Colonel Sir David Prain, "for the application of botany to the development of the raw materials of the Empire." Sir David is one of the most distinguished of living botanists. When Director of the Royal Botanic Gardens at Calcutta he developed the Government cinchona plantations of India, and organised a system for the cheap distribution of quinine through the post offices, thereby making the drug familiar in every village of India and saving unnumbered human lives. Afterwards, as Director of the Royal Botanic Gardens at Kew, his work was of great scientific importance and of great value to those engaged in the timber and plant products industries.

THE Faraday Society will hold a general discussion on "Photochemical Reactions in Liquids and Gases" at Oxford on October 1-2 next. The subject will be discussed under two main heads: (1) Einstein's Law of Photochemical Equivalence, (2) the Mechanism of Photochemical Reactions. Part 1 will be opened by Prof. A. J. Allmand (King's College, London) and Part 2 by Prof. M. Bodenstein (Berlin). In addition to the leading English workers on photochemical action, many distinguished investigators from the continent and the United States have signified their intention of taking part in the proceedings, and an attractive programme of papers has been prepared. It is hoped to accommodate all who attend the meeting at Exeter College and Lincoln College. Non-members of the Faraday Society may attend the meeting, and those desirous of doing so are asked to communicate at once with the Secretary of the Faraday Society at 90 Great Russell Street, London, W.C.1, from whom full particulars may be obtained.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Head of the engineering department of the Swindon and North Wilts Technical Institution—The Principal (June 24). A lecturer in electrical engineering at the Municipal Technical College, Swansea—The Director of Education, Dynevor Place, Swansea (June 24). A research worker in the Department of Scientific and Industrial Research, on adhesives—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (June 27). An assistant lecturer in mathematics at the Municipal College of Technology, Belfast—The Director of Education, Belfast (June 29). A junior assistant in the Information Bureau of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 4). A junior assistant in the metallurgy department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (July 4). A lecturer in physics and mathematics at the Northampton Polytechnic Institute—The Principal, St. John Street, E.C.1 (July 6). A lecturer in physics in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (July 11). A junior assistant (physics) at the Shirley Institute, British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (July 15). A lecturer in zoology, with special reference to cytology and experimental zoology, in Edinburgh University—The Secretary (July 23). A lecturer in biology at the Cheshire School of Agriculture—The Principal, Reaseheath, Nantwich. An evening lecturer in bacteriology at Battersea Polytechnic—The Principal.

Our Astronomical Column.

COMET TEMPEL (2).—Information has been received from the International Astronomical Union Bureau at Copenhagen that this comet has been detected by Mr. Stobbe (observatory not stated), as follows:

	G.M.T. (?)	R.A.	N. Decl.
June 11	$23^h\ 42{\cdot}0^m$	$18^h\ 23^m\ 28^s$	0° 13′

The magnitude is stated as 12·0, which is fainter than anticipated, and hence explains why it has not been found by the several observers in England who have looked for it. It is approaching the earth and the sun and should brighten considerably. The perihelion date will be about August 7·6, which is within two days of the anticipated date. The following are two predicted places (approximate) for midnight (0 hr.).

	R.A.	S. Decl.
June 18	$18^h\ 25{\cdot}8^m$	0° 46′
,, 26	$18^h\ 28{\cdot}7^m$	2° 55′

PROVISIONAL SOLAR-CONSTANT VALUES.—Vol. 77, No. 3 of the Smithsonian Miscellaneous Collections contains provisional solar-constant values for the period August 1920-November 1924, together with monthly and decade means from 1918. It is stated by the compilers, Dr. C. G. Abbot and his colleagues, that they would have preferred not to make public any provisional values at present, as the variation of the sun is seldom large and there is a great difficulty in maintaining a sufficiently high standard of accuracy in the solar measurements to give the magnitudes of the changes very closely. Owing, however, to the growing interest in the "variable" nature of the sun's output in radiation and its promise of usefulness in connexion with weather reports for the study of the dependence of weather and climates on these variations, the demands for the observations have been so insistent that the authors now "publish briefly at this time the best knowledge we now have." The reader is, however, given to understand that small modifications will probably be made in the final publication, which they hope to make in Volume V. of the Annals of the Astrophysical Observatory.

Table I., covering 25 pages, gives a summary of the results from Mt. Harqua Hala and Montezuma, while Table III. gives the decade and monthly mean solar-constant values 1918 to 1924. Several interesting curves are given, one of which shows that increased solar activity brings higher solar-constant values.

Research Items.

THE RELIGION OF THE PRIMITIVE HUNTER.—In the *Sociological Review* for April, Mr. Christopher Dawson, in a communication on "Religion and Primitive Culture," argues that the remarkable resemblances in the "hunting cultures" of North America and Siberia, Australia and South Africa, to the culture of palæolithic Europe are too great to be fortuitous. They have a common religious foundation, a common attitude to life which may be called the "religion of the hunter." The fact that totemism extends from West Africa to North America, and was one of the constituent elements in predynastic culture in Egypt, is fatal to the claim of Australia to be the home and centre of diffusion of totemism as held by some writers, and makes it difficult to believe with Prof. Elliot Smith and his school that it was diffused by the historic Egyptians of the "Archaic Civilisation." Judging by the North American evidence, it seems clear that the religion of the hunter—the belief in animal guardian spirits—lies at the root of the whole development. First came the guardian spirit of the Shaman; then of the individual, and as population increased and the group became more complex, the same idea became the principle of the social organisation, on one side of the secret society with a common guardian spirit, on the other of the totemic clan, a group of kinsmen inheriting a common guardian spirit.

THE MAGIC OF COLOUR.—Mr. Stewart Culin, in a lecture delivered to the Textile Color Card Association of New York in February last, which is published in the *Brooklyn Museum Quarterly*, vol. 12, No. 2, describes some of the magical beliefs relating to colour, especially in China and Japan. The significance of colour with the fundamental associations, which have come down to our own day, was established when a belief in magic was universal. This applied in five directions, the seasons, the elements, the planets, the points of the compass, and the notes in the musical scale. In an old Korean book in Mr. Culin's possession, the musical notes are indicated in colour. The Chinese flags of the Manchu bannermen, green, red, white, black, and yellow, correspond with the east, south, west, north, and middle. Red is the colour for expelling demons and preponderates in the garments of European peasants, and this colour is used in the placards which the Chinese paste on their doors at the New Year. Yellow was the colour of the middle, of the element earth, of Saturn, of gold, of the grain rice, and of the emperor. Colour determined the value of gold, of precious stones, and turquoise and jade. In Japan colour flourished chiefly in Buddhist ceremonial and in the Imperial court; but the accessories of Shinto are without colour, and the Japanese of to-day dislike Chinese colour.

THE BLUE WHALE.—Sir Sidney Harmer (Proc. Zool. Soc., 1923, p. 1085) contributes some interesting observations on two enormous cervical vertebræ of the blue whale, found in the Panama Canal Region and presented to the British Museum by Mr. F. Mitchell-Hedges. These vertebræ had the epiphyses completely fused, and this fact, coupled with their large size, when compared with available evidence from other specimens, bears out the original estimated length of the specimen of ninety-eight feet. This would appear to establish the fact that the northern blue whale may grow to at least one hundred feet, and that there is no substantial basis for the suggestion that the southern race of this whale is larger than the northern. As the blue whale is considered an ice-loving species, this record from the tropics is of considerable interest from that point of view, as well as from its bearing on the possibility of a migration across the equator of blue whales from the northern to the southern hemisphere, and vice versa. Further evidence of the size at which the epiphyses in this whale become ankylosed is supplied by Sir Sidney in Proc. Zool. Soc., 1924, p. 1175. In the southern race of the whale specimens measuring eighty-four feet were found to have the epiphyses free, while in one of ninety-one feet they were fully ankylosed.

BEAKED WHALES.—In Proc. Zool. Soc., 1924, p. 541, Sir Sidney Harmer reviews the genus Mesoplodon, with special reference to *M. mirus* and *M. densirostris*, and discusses the cranial characters of the beaked whales in general, with a valuable criticism of the importance of the antorbital region of the skull as a valuable character for purposes of classification. He rejects the genus Paikea of Oliver as instituted on insufficient grounds, and includes it as a synonym of Mesoplodon. Detailed descriptions of two skeletons of *M. mirus* from the coasts of Ireland (two out of the only three known specimens) and one of *M. densirostris* from Madeira conclude a valuable contribution to our knowledge of Cetacea. Sir Sidney Harmer's ninth report on Cetacea stranded on the British coasts covers the years 1923–24, and, while not including any species of great rarity, several interesting records are deserving of notice. The white-beaked dolphin was more numerous than usual, and appears to be establishing its claim to be regarded, after the common porpoise, as the commonest British cetacean. Special attention is directed to the record of the false killer (*Pseudorca crassidens*) in a sub-fossil condition in the Cambridgeshire Fens, and to the unexplained occurrence of vertebræ of three large rorquals (two blue whales and one common rorqual) off Newhaven, Sussex.

MOSQUITO CONTROL.—The International Health Board of the Rockefeller Foundation has issued a very valuable pamphlet on "The Use of Fish for Mosquito Control." It includes a brief historical survey of the matter, a very complete summary of the work which has been accomplished in all parts of the world, with illustrations of the fish employed, and a general statement of the biological principles on which the control of mosquitoes by fish is based. Special attention is given to the requirements of fish as mosquito destroyers, and to the conditions under which they may be successfully used for this purpose, emphasis being laid on the use of indigenous species where possible. It is intended mainly for the use of the field staff of the Board, but has obviously a wider field of interest, and the biologist particularly will welcome this full statement of the results which have led to the elaboration of this method of controlling yellow fever and malaria, and to its successful establishment in various parts of the world.

A NEW PROLIFERATING LARVAL TAPEWORM.—B. Schwartz describes (Proc. U.S. Nat. Mus., vol. 68, art. 24, 1924) cysticerci, which he refers to a new species of Tænia, from the lung of an Alaskan porcupine (*Erethizon epixanthum*). The cysticerci occur singly or in colonies; in the latter case the basal stalks or peduncles issue from larger stalks which are in the lung tissue. The scolex has four elliptical suckers and a double row of hooks—18 large and 18 small.

MYCETOZOA OR "POLYANGIDÆ."—Roland Thaxter in 1892 first described as Myxobacteria, primitive minute organisms which in the vegetative state, though retaining their separate individuality, radiated outwards as they multiplied on the substratum, as a slimy plasmodium-like mass. As their name suggested, Thaxter thought the individual organisms, multiplying probably by transverse fission, were allied to the bacteria, the whole mass in its slimy aggregate recalled the plasmodium of the Myxomycetes (or Mycetozoa). Jahn has recently reclassified the group, adding new forms that he has first described ("Beiträge zur botanischen Protistologie." 1. Die Polyangiden. Leipzig: Gebrüder Borntraeger, 1924. 10*s.* 6*d.*), and, not satisfied with the affinities suggested by Thaxter's name for the group, rechristens them the Polyangidæ, after the generic name under which a species of the group was first recorded (in 1809). Thirty-six species are now described under eleven genera, which are grouped in four families. The systematic characters are mainly based upon the form and structure of the very small, but sometimes very striking fruit bodies, into which the slimy mass of microscopic organisms aggregate themselves under suitable conditions, though the family regarded by Jahn as most primitive only heaps into irregular masses, never forming definite cysts.

STARCH AND OTHER CELL-CONTENTS.—The Mémoires de la Société Royale des Sciences de Bohême for 1923, published at Prague (1924), contains a number of papers, mainly mathematical and botanical; they are written in Czech or German and followed by a summary in French or English. Several botanical papers are systematic or ecological in nature. In addition, W. S. Iljin describes further experiments dealing with the effects of salts upon the hydrolysis of starch (NATURE, September 15, 1923, p. 407). Sodium chloride in concentrations from 0·05 M to 0·1 M causes the hydrolysis of the starch in the guard cell of stomata in many plants, but in the case of halophytes much higher concentrations are necessary. Vegetable cells placed in dilute solutions of maltose synthesise starch energetically, but the process is stopped by the addition of sodium chloride or other salts to the solution. E. Votoček and V. Ettel direct attention to the ease with which galactose yields a crystalline dibromo, 2.4-phenylhydrazone, thus permitting its quantitative separation under certain conditions from xylose, rhamnose, glucose, fructose, etc., but not unfortunately from arabinose, with which it is so often associated after hydrolysis of plant pectins.

THE FUNCTION OF NICOTINE IN THE PLANT.—J. J. Theron and J. V. Cutler have an interesting contribution to this problem, which is of both theoretical and commercial importance, in the *South African Journal of Science*, vol. 21, 1924, pp. 189-194. They show that the total nicotine content in the plant increases up to the flowering stage, after which there is a rapid decline, whilst the formation of seed immediately reduces the percentage of nicotine. They conclude that the nicotine is a storage product which is drawn upon to form other nitrogen reserves within the seed. The authors also record continued metabolic change in the harvested crop which produces a considerable diminution of nitrogen and can be prevented by methods which raise the temperature of the leaves shortly after the crop is cut.

THE GEOLOGY OF THE CHATHAM ISLANDS.—Early last year the Otago Institute organised an expedition to the Chatham Islands, and a preliminary account of the geological observations has now been given by R. S. Allan in the *New Zealand Journal of Science and Technology* (Feb. 1925, p. 290). The Islands consist structurally of a series of faulted blocks which in the late Pliocene were relatively elevated or depressed to different levels, and have since been eroded, and linked up by immense sand banks and spits. The most southerly block of the main island now rises to nearly 1000 feet and ends suddenly in a magnificent line of basaltic cliffs up to 700 feet in height. The northern part of the island is low-lying and swampy, but here the oldest rocks, quartz-mica-schists striking approximately east and west, are exposed along the shores. Lithologically these schists resemble those of Otago, but the comparison throws no light on their age, as the Otago schists themselves have been referred to various periods from the early Palæozoic to the early Mesozoic. Lying on the foundation stones of the Islands with great unconformability are Bryozoan limestones and limburgite-tuffs of Oligocene age. Unconformably on these are Middle Pliocene sands and grits containing a fauna, 63 per cent. of which is identical with that of corresponding age in New Zealand. The Oligocene limestones, in striking contrast, have only 4 per cent. of the species in common. The volcanic rocks are of great interest and are referred to two main epochs of eruption. The earlier series (Oligocene) consists solely of tuffs and flows of limburgite. The later series (younger than the Oligocene and older than the late-Pliocene or Pleistocene fault-movements) is mainly made up of basalts, but associated with the predominant type are mica-andesite, trachyte, and phonolites.

ORIGIN OF PLATINUM AND GOLD NUGGETS.—Detailed physico-chemical analyses of platinum nuggets have enabled Prof. S. F. Zhemchuzhny (*Ann. Inst. d'analyse physico-chimique de l'Acad. de Science de Russie*, vol. 1, liv. 2) to come to the conclusion that the nuggets do not differ in their structure from alloys. Certain details of structure, as well as the presence within the mass of platinum of crystals of osmic iridium and of small round cavities, corresponding to bubbles of air, show that platinum has crystallised from the magma in which it has been dissolved in a molten condition. Gold nuggets, according to the same author (*loc. cit.* 2, liv. 1), are of a quite different origin, their structure and physical properties indicating that they have been formed by crystallisation of gold from solutions of that metal in the water solutions of sulphur salts or of sulphates of iron oxide, which are products of oxidation of gold-containing sulphur pyrites.

THE POLAR AURORA.—Prof. L. Vegard has recently shown by means of experiments made with solidified nitrogen diluted with argon at the temperature of liquid hydrogen, that it was possible to reproduce the N_1 aurora line by bombardment with cathode rays. In collaboration with Messrs. H. Kamerlingh Onnes and W. H. Keesom he describes in the *C.R. Acad. Sci.*, Paris, April 6, experiments in which the nitrogen was diluted with neon, and cooled with liquid helium. The N_1 band changes, when the proportion of neon is increased, in a similar manner to that observed with nitrogen and argon at the temperature of liquid hydrogen, but with a much slower displacement towards the red as the dilution is increased; the position of the principal maximum, indeed, remains nearly constant until 70 per cent. of neon is present. From this point on, the maximum commences to shift rapidly with an increase in the proportion of neon, on account of the resulting diminution in the size of the nitrogen particles. When the proportion of nitrogen has been reduced nearly to zero the N_1 band becomes a line, with wave-length 5578·6, which very nearly coincides with the green line of the aurora. The small difference is attributed to a specific action of the neon,

so that it is probable that, if similar small particles of nitrogen could be bombarded with electrons at very low temperatures without any additional substance, the auroral green line would be given out.

THE DENSITIES OF LIQUID AND GASEOUS HELIUM.—When the densities of a gas and of its liquid form, in contact with one another, are plotted against temperature, the two density curves meet at the critical temperature, the joint curve being roughly parabolic. If now the arithmetic means of the two densities at the different temperatures are plotted, the graph has been found to be nearly a straight line, which also passes through the critical point. In the *C.R. Acad. Sci.*, Paris, March 30, E. Matthias, C. A. Crommelin, H. Kamerlingh Onnes, and J. C. Swallow give the results of a series of measurements which verify this law of the rectilinear diameter for helium, the densities having been measured for nine temperatures ranging from 4·71° abs. down to 2·30° abs. The deviations from rectilinearity are small, but a little larger than for hydrogen and neon. By means of the equations deduced it is possible to calculate the value of the critical temperature of helium $\Theta = 5{\cdot}19°$ abs., and the critical density $\Delta = 0{\cdot}06930$. The critical coefficient $R\Theta\Delta/\Pi$ is equal to 3·270, where R is the gas constant and Π the critical pressure; this is very nearly the same as for hydrogen (3·276).

DIRECTION OF RADIO SIGNALS DURING THE ECLIPSE OF JANUARY 24.—Prof. Merritt communicates a paper on the changes observed in the direction of radio signals at the time of the eclipse on January 24, 1925, to the April number of the Journal of the Franklin Institute. As a part of the programme of eclipse observations at Ithaca, N.Y., records were kept during the morning hours of January 23, 24, and 25 of the apparent directions of stations at Schenectady and New York as indicated by radio direction finders. Graphs are given in this paper of the results obtained. The observations were begun at least an hour before sunrise, and show in a striking way the large and extremely rapid changes in direction characteristic of night conditions. The time at which "day conditions" are established seems to vary largely from day to day. On the day of the eclipse, the night conditions persisted until an hour after sunrise, and this although the sun had been shining brightly. On the next day, which was very cloudy, day conditions were reached while it was still almost as dark as midnight. It is concluded that if the observed direction changes are due to sunlight at all, they must be brought about by the changes caused by light in the upper regions of the atmosphere. Although the variations in the direction during the early hours of January 23 were much less marked than on January 24, yet there is a definite indication that night conditions persisted nearly as long on both days, although January 23, like January 25, was a very cloudy day. There is some slight evidence that persistence of night conditions after sunrise is associated with high barometric pressure and a large pressure gradient. On the day of the eclipse, night conditions persisted until half an hour after the eclipse began. Six minutes after the end of totality a systematic drift towards the south began, and for eight minutes the settings indicated that the signals were coming from a direction 15° south of the true direction of New York. Thirty-five minutes after totality, the readings had become normal. It is stated that if the effect is due in some way to changes in the ionic concentration resulting from changing illumination in the upper atmosphere, then the delay in the appearance of an eclipse effect until after the end of totality might have been expected.

SEPARATION OF SELENIUM AND TELLURIUM.—V. Lenher and C. H. Kao describe a new method of separating selenium and tellurium in the Journal of the American Chemical Society for March. To a solution of the oxides in 100 c.c. of concentrated hydrochloric acid, 50 c.c. of acid saturated with sulphur dioxide is added. After vigorous stirring, and on standing, selenium settles out and is readily filtered off. The tellurium is then obtained from the mother liquor by precipitation with sulphur dioxide and hydrazine. The temperature of the solutions should never exceed 30°.

CONDUCTIVITY IN SOLUTION AND CONSTITUTION.—The conductivities of many saturated salt solutions in liquid hydrogen sulphide at the temperature of solid carbon dioxide have recently been measured by G. N. Quam and J. A. Wilkinson (Journal of the American Chemical Society, April). Many salts form conducting solutions; halides of the phosphorus family show increased conductivity with increase of atomic weight, except in the case of bismuth, which forms an insoluble compound with liquid hydrogen sulphide. The conductivity of solutions of acetic acid derivatives is higher the greater the negativity and positivity of the groups joining the compound. Ammonium chloride is insoluble in the solvent; the introduction of alkyl groups in place of hydrogen causes the compound to become soluble and the solution conducts in proportion to the number of groups introduced. Pure liquid hydrogen sulphide has a conductivity less than 1×10^{-11} reciprocal ohms.

A CONTINUOUS REFRIGERATOR. — Refrigerating plants may be broadly grouped into the vapour compression type and the vapour absorption type. Vapour absorption machines are generally intermittent in action, since the ammonia has to be expelled by heat from a solution in one stage of the cycle and absorbed back again in a later stage. These operations necessitate the manipulation of valves. In the issue of the *Machinery Market* of May 1, there is a description of a novel method of continuous refrigeration, working on the vapour absorption system, which is the invention of two Swedish engineers, Munters and Platen, and for which they were awarded the Polhem Medal in 1924. The Munters-Platen system has no moving parts and the pressure is the same through the circuit. The evaporator contains a strong solution of ammonia. At the base of the evaporator is a heater round the body of which is coiled a pipe which projects above the surface of the liquid. When heat is applied this pipe becomes so hot that the solution inside it boils, and rising, discharges water into the evaporator, the ammonia gas being liberated. The ammonia solution is drawn from an absorber into the evaporator by this novel thermo-syphon device which induces automatic circulation. The ammonia gas given off by the evaporator is passed into a condenser and liquefied. This liquid ammonia then passes into a generator, where it gasifies absorbing heat from its surroundings, thereby producing refrigeration. The ammonia gas from the generator mixes with the hydrogen filling the system. The resultant gas mixture is heavier than pure hydrogen and enters an absorber near the bottom where it meets a shower of water. The water absorbs the ammonia, and the hydrogen, denuded of the heavier ammonia gas, rises and returns to the generator, entering near the top. Thus there is an automatic circulation. The connecting pipes are so arranged as to function as heat interchangers in both the gas and the liquid circuits. The only motive force for the whole apparatus is the heating coil in the evaporator.

The Origin of Species as revealed by Vertebrate Palæontology.[1]

By Dr. HENRY FAIRFIELD OSBORN,

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I. JUST as in the inorganic world energy directs matter, not matter energy, so motion or function invariably precedes form; change of motion or function precedes change of form.[3] A static condition of form, in either the trunk, the limbs, the vertebræ, or the teeth, implies a static condition of habit, of habitat, or of function; consequently, a new habit (ontogeny), in either the unchanged or changing environment, gives rise to a new movement or function and results in change of form in the organ most directly affected. Each particular organ and each part of an organ may manifest a dependent or independent change of function and consequent change of form; thus a series of organs or of closely related or similar parts of the same organ may manifest either harmonic or disharmonic change. This principle, first observed by Aristotle, more or less developed by Lamarck, and more specifically by Cope, has been confirmed by such observations as those of Arbuthnot Lane.

II. *The principle of compensation* on economy of growth, first formulated by Aristotle and later more clearly by Geoffrey St. Hilaire (*loi de balancement des organes*), whereby the increased motion or function of one organ is compensated for by diminished motion or function of another organ, is a bio-mechanical principle thoroughly established in vertebrate palæontology; not only adjacent or related organs, but organs widely separated functionally and anatomically rigidly obey this economic law, which receives its most substantial demonstration in palæontologic series. Its corollary is development and perfection through use and degeneration through disuse.

III. *The principle of continuity*, in which evolution is like growth, is one which could be discovered and observed only in palæontology, where large numbers of successive lines of descent of organisms can be observed. To our knowledge, this principle was first observed by the invertebrate palæontologist Waagen in 1869, who observed continuous change whereby a minute and inconspicuous organ gradually in geologic succession becomes so conspicuous as to constitute a stage; he named this stage a "mutation," a term now used in palæontology in a sense directly opposite to its borrowed use in botany and zoology. Following the establishment of the principle of continuity by many invertebrate palæontologists came the vertebrate studies of Déperet and especially of Osborn, who in his monograph of researches on the evolution of the titanotheres[4] has firmly established this principle. Every bio-mechanical organ in every part invariably arises and evolves through a continuous process, and in this respect evolution is a forecast of ontogeny or individual development. Each new adaptive organ rises gradually and continuously out of the germ-plasm, passes into a stage of mechanical perfection, and then subsides into the germ-plasm and disappears.

IV. *The principle of germinal or evolutionary trend in a definite direction.* So far as I know, this was first expressed by the Austrian palæontologist Neumayr, who applied to this trend the term "Mutations richtung," equivalent to "trend of evolution." He applied it to just such characters of ornament, shell marking, and shell proportion as those observed by his predecessor Waagen in his "mutations." This cumulative orthogenetic trend in evolution of organs in certain definite directions is also firmly established in both invertebrate and vertebrate palæontology. It may be quite antecedent to ontogenetic habit or function and, consequently, by its independence of origin is purely germinal; it is a process resident in the heredity germ itself.

V. *The principle of acceleration and retardation.* Observed by Von Baer in embryology, this principle was formulated and elaborated in palæontology by Alpheus Hyatt, a member of this Academy. It is one of the most important principles in bio-mechanical evolution, as hurrying forward or holding back the development of organs to the exact moment when they are first needed and most needed by the organism. For example, in all hoofed animals of the plains, where the young may be required to run with the mother immediately after birth, the adult limb proportions are pressed back into the prenatal stage so that the young at birth may be able to keep pace with the mother, for a few moments at least. This bio-mechanical principle can only be explained by Darwin's selection principle operating on heritable variations.

VI. *The principle of allometry*, or change of proportion as studied by Osborn in the Titanothere Monograph.[4] Adaptation through change of proportion is the most universal principle in vertebrate evolution. It is due to three causes: (*a*) the elongated neck of the giraffe, alternately cited by Lamarck and Darwin as due to inheritance or selection, may be experimentally shown to be due to the deferred inheritance of an acquired adaptation through the coincident selection of all fluctuations in the adaptive direction. (*b*) All changes of proportion which are not caused by either habit or selection fall under the principle of "Mutations richtung" or evolutionary trend, whether observed in the shells of invertebrates or in the head form of the mammals, including man. (*c*) All changes of proportion which are influenced by habit are due to this dual mode of accumulation; by experimental adaptation in a single lifetime, *e.g.* the hind limbs of a dog with proportions of the running type are changed into hind limbs with proportions of the leaping type by the process brought about by the principles of compensation and self-adaptation.

VII. *The principle of rectigradation*[5] *in adaptive organs* arising from the germ-plasm passing continuously from the most rudimentary into the most efficient and highly developed stages. First observed in the Primates in 1889 by Osborn, this principle has since been confirmed in the other four great orders of mammals, the horses, rhinoceroses, titanotheres, and the proboscideans (Osborn, 1889–1911). Consequent on this principle is the "potential homology" of organs (Osborn, 1902–1911), in contrast with the true homology of Aristotle, or "genetic homogeny." For example, all the bony elements of the limb of the Tetrapoda are homologous in Aristotle's sense; all except one of the elements in the grinding teeth of the mammals are instances of potential homology rather than of genetic.

[1] Continued from p. 926.

[3] See D'Arcy W. Thompson, "Growth and Form" (Cambridge, 1917), Chapter 1. See Osborn, "Origin and Evolution of Life" (New York, 1916), Introduction.

[4] H. F. Osborn, "The Titanotheres of Ancient Wyoming, Dakota, and Nebraska," United States Geological Survey Monograph, No. 55. Now in press. A sequel to the monographs of O. C. Marsh.

[5] Eimer sets forth a graduated evolution as comparable to organic growth. The conception of rectigradation as defined by Osborn is not found in Eimer's volume, nor is the word "orthogenesis" attributed to Eimer of the same import as rectigradation. (Eimer-Cunningham, "Organic Evolution as the Result of Acquired Characters," 1890.)

VIII. *The principle of experimental adaptation.* This principle is fundamental; the "trial and error" or experimental impulse as observed in the freely moving Protozoa prevails throughout the animal kingdom and is one of the chief ontogenetic phenomena. Thus many of the higher mammals, especially the equines and the proboscideans, guide their own evolution through initiative and resourcefulness just as man is able to guide his own evolution in adaptation to new conditions of environment and biota. This principle in part accounts for the extraordinary diversity of the mammalian kingdom, which since the close of the Cretaceous has radiated from small rat-like forms into the marvellous diversity of the existing mammalian life, while the Crocodilia and Testudinata remain as they were at the close of the Age of Reptiles.

IX. *The principle of adaptive radiation*, continental, local, oceanic. While all sessile organisms like plants and sessile invertebrates develop superb bio-mechanisms simply in direct reaction to stresses and strains, and while static organisms like the Crocodilia and Testudinata remain in the condition of arrested development through conservation of habit, the freely mobile organisms like the Lacertilia and Ophidia among reptiles, the birds, and all divisions of the mammals enter new ontogenetic and phylogenetic phases through the principle of adaptive radiation (Osborn), which is an elaboration of Lamarck's *ébranchement* and Darwin's "divergence." Repeatedly in all four classes of vertebrates we observe the cycle of terrestrial, fossorial, aquatic, often ending in marine adaptation of the body and limbs. Also terrestrial, arboreal, glissant, and volant forms arise. Meanwhile insectivorous diet may branch into carnivorous or omnivorous on one hand, or into herbivorous or frugivorous, leaf-eating, browsing, grazing adaptations of the general mechanism on the other. Under this principle as developed by Osborn fall the bio-mechanical processes of convergence, the homoplasy of Lankester, and the alternative habitat discussed and elaborated by Dollo. In every instance where we can observe transition from one habitat or from one feeding to another, the adaptive response of the organism to the new conditions is immediate. The response of heredity to new conditions is very gradual. For example, heredity may conserve "palæotelic" adaptations in a "cœnotelic" exterior. In Gregory's language, "heritage" is long concealed by "habitus," but after the passage of very long periods of time cœnotely replaces palæotely and habitus gives rise to new heritage.

It should be said that, of these nine bio-mechanical principles, five were first observed in zoology and were afterwards confirmed and greatly clarified in palæontology, namely, the principle of function preceding form, the compensation principle of Aristotle and St. Hilaire, the acceleration and retardation principle, the experimental adaptation principle, and the adaptive radiation principle. Four may be observed only in palæontology, namely, the mutation principle of Waagen and the "Mutations richtung" of Neumayr, the rectigradation principle of Osborn, the continuity principle of Waagen, Neumayr, and Osborn.

These nine principles are well-substantiated facts; they are not hypotheses or theories. They include the observed modes by which new mutations, new species, new genera, new families, new orders of vertebrates arise in their bio-mechanical evolution. Every particulate organ of the skull, limbs, and teeth develops and evolves continuously in perfect bio-mechanical response or reaction to fixed or changing life environment and habit. The germ-plasm conditioning this bio-mechanical adaptation also evolves continuously, but lags far behind ontogenic adaptation, whether it be to produce the static mechanism of *Sequoia gigantea* or the mobile mechanism of the sperm whale, *Physeter macrocephalus*, or the no less marvellous mammoth, *Elephas primigenius*. Slowly following in secular time, adaptive reactions to new living environment, to new forms of self-adaptation, there is the onward germinal impulse. The rise of new rectigradations and allometrons in the germ-plasm is not in the nature of vitalism or preformation, but of more or less deferred adaptive reaction to secular experience.

Passing from the boundaries of actual observation, we may point out the bearing of the above nine principles upon some of the current hypotheses and opinions as to the causes of evolution.

It is, for example, frequently stated that environment is the cause of evolution; this is only a quarter truth, as may be seen by consideration of the following eleven observations made in palæontology:

1. *Bio-mechanical evolution* may be as rapid in a fixed physical environment like the ocean as in a changing environment like a continental surface, because bio-mechanical evolution depends as much on living environment (biota), on self-adaptation, on plastic heredity as it does upon physical environment.

2. *As to static heredity*, during the whole changing period of the Age of Mammals, mechanical evolution of two orders of reptiles, the Crocodilia and the Chelonia, was practically arrested, while mechanical evolution of the mammals was extremely rapid. This principle shows that certain animals had a fixed heredity while others had a plastic heredity.

3. *As against Lamarckism* and the Lamarckian hypothesis of the influence of animal intelligence on evolution, mechanical adaptation of the small-brained, cold-blooded reptiles was as great, or greater, during the Age of Reptiles as that of the warm-blooded, large-brained mammals during the Age of Mammals.

4. *As against Lamarckism* which involves the efforts, desires, and movements of animals in mechanical evolution, it may be said that mechanical adaptations in nerveless plants which have no movements or nervous systems are quite as remarkable as are those in the nervous and sensitive and mobile vertebrates. This proves that mechanical adaptation may be quite independent of the nervous system of animals or of the inherited effects of reaction to motion. Nevertheless, as Lamarck believed, all mobile vertebrates, like all human beings, are able to alter the trend of their evolution through the search of new food (biota), through meeting new competitors (biota), through entering new environment by geologic change or by migration (environment), through self-adaptation by new habits (ontogeny).

5. *As against Lamarckism*, in the horse family it is observed that mechanical evolution of the limbs and feet, which are rapidly improved and adapted by habit (ontogeny), is less rapid and less remarkable than the mechanical evolution of the teeth, organs which are entirely preformed by heredity and are destroyed by use and habit in ontogeny. The same is true of the marvellous mechanical evolution of the grinding teeth of the Proboscidea.

6. *As against Darwin's principle* of bio-mechanical evolution through selection and the survival of favourable variations, we observe that the mechanical evolution of the most rapidly breeding animals, such as the rodents, was much less extreme during the Pleistocene time than the mechanical evolution of the slowest breeding animals, the elephants. During the 500,000 years of the Pleistocene period there was an intensely rapid evolution of the dental mechanism of the slow-breeding elephant and little or no evolution in the dental evolution of the fast-breeding rodents.

7. *As against both Lamarck and Darwin*, the principle of rectigradation (Osborn) shows that new

mechanical adaptation organs arise out of the germ-plasm without the antecedent action of self-adaptation. (*a*) While in all parts of the skeleton the principle of mechanical self-adaptation prevails and new proportions, new characters, new adaptations, new functions, new modes of locomotion may be created in the lifetime of a single individual, all that is transmissible in heredity is the germinal variation to plasticity or adaptability in the desired direction, which may be accumulated through coincident selection as applied by Osborn, Baldwin, and Morgan. (*b*) Even more perfect mechanical adaptations arise in the grinding teeth which are not perfected during lifetime.

8. *As against mutational or saltatory hypotheses of evolution* hitherto held by Bateson and his school, the principle of bio-mechanical continuity is so firmly established that we may attribute all discontinuity in bio-mechanical evolution to abnormal, unnatural, pathogenic causes or, through recent discovery, to endocrinal disturbance. Whatever may be true in bio-chemical evolution, in colour, in immunity, in metabolism and phenomena of that order, we may be certain that the bio-mechanical evolution of the skeleton and teeth as observed in palæontology assumes and follows its firm and undeviating order.

9. *Bio-mechanical evolution as observed in full palæontological series*, whether vertebrate or invertebrate, gives the death-blow to the chance hypothesis of Democritus and Empedocles raised into a scientific system in the subsidiary fortuitous selection hypothesis of Darwin. Nature is observed to take no chances, either in the transformation of existing mechanical organs or in the origin of new mechanical characters and inventions. New parts of the organic machine arise in rudimentary condition but perfect order out of the germ-plasm when the demand for them arises; they do not arise automatically without an antecedent bio-mechanical stimulus. They play their continuously adaptive service; when no longer useful they subside and sink back into the germ-plasm, where the power of reproduction is ultimately lost.

Every single one of hundreds of bio-mechanical characters of which the evolution has been observed follows the nine principles enunciated above.

10. *The loss of bio-mechanical organs* in the vertebrates is never sudden, as if due to the presence and absence principle of Mendelism. Organs evolved through a long process of continuity show remarkable heritable stability, like longheadedness in man or in the hoofed mammals when crossed with broadheaded types. In the horse-ass hybrid, for example, most of the bio-mechanical skeletal characters transmitted are those of the horse, all of which have evolved over a very long period of time—hundreds of thousands of years. Certain of the bio-mechanical characters and most of the psychic characters are those of the ass. Thus a continuity in bio-mechanical evolution may give rise to Mendelian discontinuity in hybridising, exactly as it does in the matter of bio-chemical evolution.

11. *Every race will more or less rapidly lose its typical form* in any one of four ways consistent with the tetraplastic and tetrakinetic principle of Osborn: (*a*) by alteration of its internal energies of heredity (phylogeny); (*b*) by alteration of the external energies of environment; (*c*) by alteration of the external energies of the biota of plant and animal environment; (*d*) by alteration of the internal energies of habit or ontogeny. Any one of these four energetic changes will immediately precipitate a new action of selection, and as a secular process will alter the germ-plasm.

It appears from these eleven observations that palæontology is a two-edged sword which is equally ruthless in the Darwin-Weismann and the Lamarckian fields of speculation.

In conclusion, what really happens in the natural origin of species in bio-mechanical characters is this: *Whenever all the four energetic conditions of heredity, of environment, of biota, of habit or ontogeny, and the non-energetic condition of the struggle for existence (selection) are the same, there will arise similar ascending mutations, species, genera, families.* New similar or parallel species of hoofed animals actually arise at approximately, if not at precisely, the same rate, whether we observe them in France, Mongolia, or the Rocky Mountain region.

My rejoinder to Bateson's statement[6] that "the origin and nature of *species* remains utterly mysterious" is that thirty-six years of intensive palæontologic exploration and research have so clearly and repeatedly revealed how new bio-mechanical species arise that we can safely predict not only what the species is, but also where it is most likely to be found and in what stage of evolution it will be found. Such prediction has recently been fulfilled in a most brilliant manner in our discoveries of the Titanotheres in central Mongolia. Whatever may prove true as regards species founded on bio-physical or bio-chemical characters, the research is nearly closed on the modes of origin of bio-mechanical species, because we have little more to learn.

The *causes* of these origins is quite another matter. Some day we may be able to work out the separate contribution of each of the four energetic factors, heredity, environment, ontogeny, biota to germinal evolution. We palæontologists observe exactly how the process of germinal evolution of bio-mechanical characters goes on, adaptive in every stage, just as the embryologists observe how the process of adaptive development goes on whereby the invisible germ turns gradually into the adult and perfected skeleton and teeth. There is no accident in either mode of transformation, evolutionary or developmental, nor is there anything that we can comprehend. On the whole, the order of evolution imitates the order of development; both processes, to our mind, are equally inexplicable, and will probably remain so.

[6] William Bateson's observations on discontinuity in the origin of species first appeared in his "Materials for the Study of Variation," 1894. More recent are his British Association address in Australia and his address at the Toronto meeting of the American Association quoted from above.

Accuracy of Weighing in the Eighth Century.

TWO recent papers in the *Numismatic Chronicle*[1] contain interesting information on the remarkable accuracy of ancient weighing. Dr. G. F. Hill mentions that in a hoard of 20 gold staters of Lysimachus (*c.* 355–281 B.C.), in mint state, the extreme weights were 8·62 and 8·42 grams, *i.e.* the maximum variation was 2·3 per cent. Eleven of the coins, however, had weights with a much smaller range, namely, 8·57 to 8·52 grams, a variation of only 0·58 per cent. Dr. Hill considers this degree of accuracy to be no greater than might be obtained by cutting a bar of uniform thickness into equal lengths with an ordinary measure. The smallest weight about which the Greeks cared seems to have been not less than 0·05 gram.

Much greater accuracy is shown in certain Arabian glass coin-weights of the eighth century which are described by Sir Flinders Petrie. The average error of dinar and dirham weights of this century is 0·004 gram; in the early weights the accuracy is

[1] G. F. Hill, "The Frequency Table," Fifth Series, vol. 4, p. 76, 1924; W. M. F. Petrie, "Glass Weights," Fourth Series, vol. 18, p. 111, 1918.

even finer. Thus in 780 " the astonishing result of three weights is 32·662, 32·665, and 32·667 grains," or all within a third of a milligram. As Sir Flinders says, " to reach such accuracy it was needful to use the finest chemical balance, with closed case, double weigh the glass weights against each other, and read a long series of swings of the balance. How such accuracy was reached in the manufacture is incomprehensible. Nothing known of any other age at all approaches the fine weighing of the eighth century."

That the Arabs made an intensive study of the balance from both the theoretical and the practical sides, is well known. There is, indeed, a wide literature on this subject, which was considered to be a distinct branch of science. The celebrated mathematician Thābit ibn Qurra (836–901) wrote on the Roman balance or *qarasṭūn* (χαριστίων) a treatise (" Kitāb fi'l-Qarasṭūn ") which is still extant (MSS. Berlin, 6023; India Office, 767, No. 7). Other authors who dealt with the theory or practice of weighing are Al-Farabi, Avicenna, Qusta ibn Luqa, and Ibn al-Haitham. Most important of all, however, is the treatise written by Al-Khazini in 1121 for the Sultan Sinjar. " This is not confined to the description of various balances but includes also geometrical and physical considerations on everything connected with weight. Notably, it gives theorems on centres of gravity according to Ibn al-Haitham and Al-Kuhi; it mentions an instrument for measuring liquids, after Pappus; it touches on philosophical problems and, with Thābit, seeks for the 'different causes of heaviness.' "[2] Al-Khazini's book, which is entitled " The Book of the Balance of Wisdom," contains an excellent description of the hydrostatic balance and gives tables of specific gravities which differ in general very little from the values accepted at the present day—that of lead, for example, is given as 11·33, which compares very well with our value of 11·35.

In spite of this attention to the science of the balance, it appears that accuracy in weighing deteriorated after the eighth century. Perhaps it is a mere coincidence, but it is worth noticing that the eighth century was the time in which Arabic chemistry reached its zenith. The balance continued to play an important part in chemical laboratories, however, and we find that Al-Jildaki, who died about 1360, makes the remarkable statement that " substances do not react except by definite weights."

An excellent picture of a medieval chemical balance, in a closed glass case, is given in the British Museum MS. of Thomas Norton's " Ordinall of Alkimy."

E. J. H.

[2] Baron Carra de Vaux, " Les Penseurs de l'Islam," vol. 2, p. 181.

University and Educational Intelligence.

ABERDEEN.—Prof. R. W. Reid has intimated his resignation from the chair of anatomy, which he has held since 1889.

BRISTOL.—On Tuesday, June 9, their Majesties the King and Queen visited Bristol, where they opened the new buildings of the University, as recorded in our issue of June 13, p. 913. Before proceeding to the University, the King received an address from the civic authorities, and in his reply, referring to the great generosity to the University shown by the Wills family, said that it " is a convincing proof that the race of pious founders and benefactors did not become extinct with the passing of the Middle Ages." At the University, the Chancellor, Lord Haldane, presented an address in which he pointed out clearly the significance of the university in modern life. " It is our happy lot and duty," he said, " to cultivate and encourage learning both by imparting knowledge to those who seek it, and not less by providing facilities for its development through maturer study and research. . . . We are conscious, too, that it is incumbent upon us to bring science to the aid of industry." In his reply, the King enlarged upon this theme. The duties of the universities are: " To hold in trust for the common use the treasures of past thought, to provide for the creative minds of the present a congenial and stimulating home, to give to all the opportunity of a liberal education in the arts and sciences. . . . Their responsibilities are heavy, as their opportunities are great; and they can only rise to the full measure of their task if they be strong in public sympathy and support."

Honorary degrees were conferred on June 10 upon a few distinguished representatives of the Church, arts, and science who are natives of Bristol, or have been associated with the city or the neighbouring districts through education or public service. Among these were Lord Bledisloe, Sir Richard Gregory, and Sir J. Herbert Parsons, each of whom received the degree of D.Sc.

CAMBRIDGE.—Dr. A. B. Appleton, Downing College; Mr. D. G. Reid, Trinity College; Mr. A. Hopkinson, Emmanuel College; and Mr. V. C. Pennell, Pembroke College, have been reappointed as demonstrators of anatomy.

The Council of the Royal Agricultural Society has notified the University that it is prepared to grant the interest on the money given to the Society in 1896 by the late Sir Walter Gilbey to the University of Cambridge to assist the University to maintain the Gilbey lectureship in the history and economics of agriculture.

LEEDS.—Dr. W. H. Maxwell Telling, who has occupied the chair of therapeutics for the past two years, has been elected University professor of medicine and head of the Department of Medicine, as from October 1, on the retirement of Dr. T. Wardrop Griffith.

LONDON.—The Johnston-Lavis Geophysical Collection, which was bequeathed to the University of London by the late Dr. Henry James Johnston-Lavis, will be formally opened at University College on Thursday, June 25, at 4 P.M. After the opening ceremony has been performed by Sir Henry A. Miers, Vice-Chancellor of the University of Manchester, in the main college buildings, visitors will have an opportunity of inspecting the Collection in its temporary quarters at 134 Gower Street. Those who would care to attend are requested to communicate with the Secretary of the College.

THE Liddle triennial prize, value 120*l.*, of the London Hospital Medical College is being offered for an essay on " The etiology and treatment of primary high blood pressure." Competing papers should be sent by at latest January 30 next to the dean of the college, Turner Street, E.1.

APPLICATIONS are invited for the Gull studentship in pathology and allied subjects, including bacteriology, at Guy's Hospital Medical School. The studentship is open to candidates who have studied at the medical school of Guy's Hospital. It is of the annual value of 250*l.* and is tenable for three years. The latest date for the receipt of applications, which should be sent to the Secretary of the Board of Electors, at the School, is July 4.

Early Science at Oxford.

June 22, 1686. The Minutes of the Dublin Society from Apr. 26, to May 17th were read: Also a discourse of Mr. Caswels, Shewing how the *Shadow* may *goe back* on an Horizontal plane in any latitude, if the stile point betwixt the Tropics; also on any other plane unlesse the situation thereof keeps the Sun from shining long enough thereon; together with the calculation of the time and quantity of the shadow's regression, according to the various situations, of the stile and plane.

Mr. Lloyd haveing observed that many curious Travellers when they visit the Repository, doe occasionally relate some remarques of their own experience, concerning things of *Nature* and *Antiquity*; he thought it might prove of some consequence to provide a Book that should lye in the Repository; wherein he might breifly set down, the contents of such relations; desireing each Gentleman to subscribe to what he communicated.

'Twas ordered that such relations should be transcribed into the Minute Book in ye method indicated by two examples written out in full by Mr. Lloyd.

June 23, 1685. Dr. Plot presented severall Birds, as ye Puffin, Razor Bill, and ye Eligug, together with ye Egges of each Species; the Egges were observed to be large, but especially those of ye Puffin.

He communicated an account of incombustible cloth, drawn up by way of letter to Mr. Bayly, Fellow of ye Royal Society, and Mr. Wait, both Merchants of London; this discourse was read.

June 24, 1684. A Letter from Mr. Aston, dated June ye 21st 1684 was read; which mentioning an experiment lately made before ye Royall Society, for finding ye quantity of air, contained in Iron; it was ordered, that Mr. Aston be desired to communicate ye manner, and method, of that Experiment. In this letter were contain'd ye Minutes of ye Dublin Society, from Aprill ye 28th to June ye 2d:, which mentioning that a Dog, haveing about 2 inches in depth, and 3 or 4, in bredth, cut off from one of ye lobes of his lungs, recovered it without any injury to him, Mr. Musgrave assured ye Society, that ye same Experiment was tried by Dr. Lower, here in Oxon, many years since, with ye same success, as he heard from Mr. Fry, formerly a Chyrurgion in this Town, who assisted ye Doctor in that Experiment.

These Minutes giving also an account that one of ye externall jugulars of a Dog, was tied without injuring ye Dog. Mr. Musgrave read a paper, acquainting ye Society with what he did in this kind ye last March: the paper is as follows: Sometime in March last, I tied ye 2 externall jugulars of a dog, and cut off ye veins, on this side of ye Ligatures, towards ye heart: The same experiment was tried many years since, by ye famous Dr. Lower (see his book *de corde*, pag: 112, ed. Amstel: 1671).

These were ye strange effects of ye Doctor's experiment, and my success, in repeating it, was also somewhat surprising, but on a different account; for I could never find, that ye dog, on which I tryed this experiment, was any way concerned, otherwise than at ye wound; I found no alteration in him at all, that I could impute to ye stoppage of ye circulation, in ye veins before mentioned &c.

About 3 weeks after this experiment, ye wounds being now heald, I tried another Experiment on ye same dog, under which he died: I examin'd him as to ye jugulars, which I found almost dried up:

This experiment was tried in ye presence of Mr. Paige, and some others, of New College.

Ordered, ye Eclipse of ye Sun on 2 July next, to be strictly observed.

Societies and Academies.

LONDON.

Royal Society, June 11.—R. **Magnus**: Animal posture (Croonian Lecture). Postural centres in brain-stem compound the body musculature to combined action. Postural stimuli arise from many different sense organs. Change in position of one part of the body is followed by postural (usually harmonious) changes in other parts. Postures are adapted to environment by combined action of distance receptors and attitudinal reflexes. The righting function, absent in decerebrate, is present in midbrain animals. Righting reflexes evoked from labyrinths, exteroceptors, and proprioceptors, bring head and body into normal position. Optical righting reflexes are present in higher mammals only. Paralysis of one righting apparatus is usually compensated by other righting reflexes. Centres for righting are arranged subcortically. The resting position of the eyes changes with different positions of head, and is controlled by postural reflexes. In animals with lateral eyes (rabbits) the visual world remains fixed in spite of head movements. This is accomplished by the combined action of otolithic and neck reflexes. Motor reflexes from the semicircular canals initiate these static reactions of the eyes. Centres for all these reflexes are arranged in three groups. The red nucleus is the centre for two of the righting reflexes. Labyrinthine reactions have greater importance in lower mammals. Postural function of other parts of brain is largely unknown.

Royal Anthropological Institute, May 5.—V. **Gordon-Childe**: The lake dwellings in Europe in the light of the new excavations. Prior to 1920 our conception of the development of civilisation among the inhabitants of the pile villages of the Alps was perforce based on *a priori* typological analysis of the heterogeneous material dredged up haphazard. These conceptions were largely erroneous. On Lake Neuchâtel, Dr. Vouga has found at several sites no less than four superimposed settlements. The oldest villagers used jadeite more freely and made much finer pottery than their successors. They possessed all the domestic animals and depended less on food-gathering than the later settlers; on the other hand, they may have been cannibals. In Wurtemburg the studies of Runerth of Tübingen have rendered possible the reconstruction of several types of neolithic houses and revealed pottery some of which is related to both the earliest fabrics of Lake Neuchâtel and those in use in the Danube Valley in the second neolithic period there. Beside the well-known Bronze Age village on Laibach Moor, an earlier settlement has been identified which, despite a "neolithic" inventory, probably belonged to the dawn of the age of metal as whetstones were found. On Lake Alvastra in Sweden a pile dwelling of the stone age was excavated in 1911. Its occupants had practised agriculture and possessed artefacts similar to those of the megalith builders on the coasts, but their pottery and celts were of types proper to the food-gathering population of the "dwelling-places." The "neolithic" elements from the Swedish and Swiss lake dwellings are fundamentally different. It is therefore impossible to attribute both the pile-dwelling habit and the neolithic civilisation to the "brachycephalic invaders" assumed by classical theory. Incidentally the more easterly and southerly lake-dwellings at Laibach and in Bosnia are later than the western and northern. On the other hand, a race of hunters and fishers had inhabited rafts in the early neolithic (dolmen) period in Scandinavia and even earlier in the mesolithic period in Denmark and

Yorkshire. At the same time much of the industry revealed in lake dwellings south of the Alps and Scandinavia may be derived from the mesolithic—horn harpoons and sleeves, wooden boomerangs, phalange whistles, etc. It is therefore suggested that the lake dwellers are descendants of the mesolithic food-gatherers, that the lake dwellings are improvements on the mesolithic raft—an intermediate phase being illustrated by the platform structures of Denmark and West Switzerland—but that the neolithic arts were borrowed from more advanced peoples; the Danubians in the Alps, the megalith builders in Scandinavia.

Geological Society, May 6.—E. B. **Bailey**: The Tertiary igneous geology of the Island of Mull. In Judd's region of central pneumatolysis (propylitisation), within an area measuring 15 miles in diameter, it is impossible to find a lava that has retained its olivine undecomposed. Referring to Judd's conception of central subsidence, it now appears, from the disposition of lava-types and other considerations, that central subsidence culminates in two adjacent calderas. The occurrence of many pillow-lavas within one of these calderas—at the centre of a manifestly terrestrial volcano—points to the frequent presence of a crater-lake. The crater-hollow must have been renewed by intermittent subsidence. Ring-dykes are numerous. There is conspicuous folding attributable to the lateral expansion of an early ring-dyke. Similar folding does not recur in connexion with later ring-dykes. Several ring-dykes in Mull show gravitational differentiation, which took place during crystallisation.

Physical Society, May 8.—E. **Hughes**: A magnetic bridge for testing straight specimens and an analysis of the hysteresis loop of cobalt-chrome steel. The author employs a permeameter resembling that of Iliovici, in which the currents in two coils providing the M.M.F. of a magnetic circuit containing the specimen are adjusted until no magnetic potential difference exists between a selected pair of fixed points on the specimen. In the present apparatus the required absence of magnetic potential difference is tested by bringing up a yoke until its ends abut upon the two points in question: the approach of the yoke should excite no current in a search coil wound on the specimen and connected in a low-resistance galvanometer circuit. Resistance is then added to the galvanometer, and the deflexion caused by a reversal of the two magnetising currents enables the permeability to be calculated. To form a permanent magnet the energy of which per c.c. is within 5 per cent. of the maximum obtainable, a magnetising force of upwards of 1000 C.G.S. units must be applied.—M. C. **Johnson**: The experimental control of electrically broadened spectral lines. Concentration of ions is the obvious controlling factor if the Stark hypothesis be adopted; recombination of ions on this hypothesis may explain the capacity and inductance curves obtained in these experiments, between 0·3 and 1·0 Å.U. This view is further tested by controlling the broadening without altering the current in the tube or the period of the discharge. The several effects involved are accounted for on the theory that line width depends on the number of charges which surround an emitting particle.—K. Rangadhama **Rao**: The spectra of the metals of the aluminium sub-group. Continuing the previous work on absorption of light by thallium vapour, the author has now studied the absorption of thallium vapour from λ2400 to λ2000, and that of indium from λ6000 to λ2000. The absorption tube was of steel, and provided with quartz windows at the ends, and absorption was studied with a quartz spectrograph. The absorption spectra indicate marked similarities. None of the lines of the principal series appeared in absorption, even at the highest temperatures used. One remarkable feature is the very marked absorption of the members of $1\pi_2$—$m\delta'$.

CAMBRIDGE.

Philosophical Society, May 4.—R. H. **Fowler**: A theoretical study of the stopping power of hydrogen atoms for α-particles. The problem of the stopping power of light atoms for α-particles has been reopened by Bohr, in a way which will allow of the retention of a purely mechanical calculation of the effect on the α-particle in spite of the quantum restrictions on the reactions on the atoms. This mechanical calculation of the energy lost by the α-particle is carried out, taking into account the actual orbits of the electrons, instead of assuming elastically bound electrons. Circular orbits in a Coulomb field are dealt with by the method of perturbations. These must be carried to the second order for the energy, as the mean value of the first order transfer of energy is zero. The result is the same in form as Bohr's former result, but gives a slightly greater numerical value to the stopping power, which is about 10 per cent. larger as here calculated than the measured stopping powers for He and H_2.—K. G. **Emeléus**: The action of the electrical counter. With the point positive an effect can be expected proportional to the initial ionisation due to the particle being recorded, whilst when it is negative a much larger discharge should be obtained which is almost independent of the initial ionisation. Extinction of the discharge at atmospheric pressure is brought about by a local increase of pressure near the tip of the point, probably accompanied by an electric wind along the side of the needle.—F. H. **Constable**: An apparatus for the investigation of the effect of poisonous substances, and mixed vapours on catalytic activity. Vapour mixtures of known composition can be supplied at a constant rate to the catalyst, which is maintained at a definite temperature. The general theory of "Centres of Activity" has been applied to selective poisoning. The decay of the reaction velocity occurs according to a logarithmic law, and the temperature coefficient is unchanged by moderate poisoning in cases in which a small fraction of the surface is catalytically active. Neither poisoning nor sintering alters the temperature coefficient of a chemical reaction, and the activity of a poisoned catalyst falls in accord with a simple logarithmic law.—R. A. **Fisher**: Theory of statistical estimation.—W. **Burnside**: (1) On the idea of frequency. (2) On the representation of the modular group of order $\frac{1}{2}p(p^2-1)$ as a group of linear substitutions on $\frac{1}{2}(p-1)$ symbols, when p is a prime of the form $4n+3$.—J. P. **Gabbatt**: On pedal quadrics in non-euclidean hyperspace.—F. P. **White**: An extension of Wallace's, Miquel's, and Clifford's theorems on circles.—H. F. **Baker**: (1) The stability of rotating masses of liquid. (2) Note on a formula for Lamé functions.—M. J. M. **Hill**: (1) On the substitution of Wallis's postulate of similarity for Euclid's postulate of parallels. (2) On the hypothesis of the obtuse angle.—J. D. **Cockcroft**: The temperature distribution in a transformer in which heat is generated at a uniform rate. The continued increase in the size of transformers has made a more exact knowledge of the temperature distribution in the laminated cores necessary. The temperature distribution in an infinite rectangular laminated core is found and the solution applied to an oil-cooled transformer core.—C. G. F. **James**: Some formulæ for scrolls and line systems in higher space.

DUBLIN.

Royal Dublin Society, May 26.—Report of the Irish Radium Committee for the year 1924. The report shows that 12,885 millicuries of emanation were issued for therapeutic purposes during the year. A temporary laboratory has been fitted up at Ballsbridge for carrying on the work of the Radium Institute. Reports from some of the largest medical users of emanation in Ireland are included. These contain numerous records of successful results obtained with radium treatment.—F. E. **Hackett**: The Zeleny electroscope and its uses as a lecture demonstration instrument.

PARIS.

Academy of Sciences, May 18.—F. E. **Fournier**: General properties of the simple satellite wave produced by the translation of hulls of forms favourable to high speeds.—Maurice **Hamy**: Cutting optical surfaces with elliptical or hyperbolic sections.—H. **Deslandres**: Complementary researches on the structure and distribution of band spectra. New measurements of absorption bands in the infra-red of oxygen, carbon monoxide, hydrocyanic acid, ammonia, water vapour and methane. For these six gases the absorption bands may be represented by the formula $K = q\frac{1062 \cdot 5}{r.s}$, where q is an integer, r is an integer, and s a third integer equal to the number of atoms in the molecule.—Marin **Molliard**: The action of high temperatures, compatible with life, on the development of cells: Studies in the mode of development of *Sterignatocystis nigra* at temperatures ranging between 36° C. and 44° C.—L. **Lindet**: The coagulation of casein in the presence of calcium salts in acid solution.—C. **Sauvageau**: The culture of the alga *Strepsithalia Liagorae*.—V. **Romanowsky**: The generalisation of an inequality of A. Markoff.—J. **Le Roux**: The variation of mass.—Raymond **Chevallier**: Ferromagnetic ferric oxide. Starting with a commercial finely powdered black oxide of iron, this is oxidised by air at a temperature of 350° C. It then has the composition of ordinary ferric oxide but is of a yellowish colour and is strongly magnetic. This ferromagnetism is lost on raising the temperature to about 700° C.—Marcel **Peschard**: The magnetisation of the ferro-nickels: thermomagnetic properties.—S. **Pina de Rubies**: New lanthanum lines in the arc spectrum at normal pressure between 3100 I.Å. and 2200 I.Å.—Jean **Lecomte**: The infra-red absorption spectrum of aldehydes and ketones. The absorption spectra of the fatty aldehydes and their isomeric ketones are not identical, and the characteristic band of the carbonyl group is not the same in the fatty and aromatic series. For a thickness of a small fraction of a millimetre, aldehydes and ketones give absorption spectra showing well-defined strong bands capable of being utilised for analytical purposes.—R. **de Mallemann**: The electrical double refraction of limonene. Kerr's constant for limonene is intermediate between that of benzene and that of toluene; it is nearly four times that of pinene, a difference attributed by the author to the presence in the molecule of a double bond external to the ring.—L. **de Broglie** and Jean Jacques **Trillat**: The physical interpretation of the X-ray spectra of the fatty acids.—Mlle. Irène **Curie** and Nobuo **Yamada**: The particles of long range emitted by polonium. The lack of homogeneity in the metallic screens employed in previous work was found to give rise to difficulties, and these screens have been replaced by a layer of compressed gas (dried air, oxygen, or carbon dioxide). It was proved that the arresting power of these gases was proportional to the pressure. In spite of the precautions taken in the preparation and preservation of the specimens, there always remained a small number of particles with a long range, and this number is nearly proportional to the quantity of polonium, but does not depend on the nature of the metal on which the polonium is deposited. These particles do not form a homogeneous group.—Georges **Fournier**: The absorption of β rays by matter.—Pierre **Chevenard** and Albert **Portevin**: Results obtained by the dilatometric study of cast irons. The dilatometric study of cast iron enables the complex transformations produced during heating or cooling to be followed, and appears to possess advantages over the thermal method for phenomena occurring in the solid state.—Xavier **Waché** and Georges **Chaudron**: The influence of thermal and mechanical treatment on the velocity of solution in hydrochloric acid.—E. **Demoussy**: The displacement of acids by diffusion. The consideration of the relative mobilities of the ions of a mixture of salt plus acid, together with a knowledge of the degree of ionisation of the acid, suffices to predict the direction of the partition of the diffusion products.—H. **Pelabon**: The direct formation of the mercury oxybromides.—Mlle. S. **Leduc**: The action of *p*-anisyl magnesium bromide and *p*-tolyl magnesium bromide on camphor.—L. **Bert**: A general synthetical method for the preparation of ω-chlorallyl cyclic derivatives, and through these, acetylenic hydrocarbons, alcohols, and aldehydes. The reaction

$$RMgX + CH_2Cl - CH = CHCl = RCH_2 - CH = CHCl + MgXCl$$

has been realised experimentally when R is C_6H_5. The reaction has been proved to be general for other aryl groups.—Georges **Brus**: The action of chlorine on α-pinene. Starting with pure pinene, free from nopinene, the author has obtained bornyl chloride, liquid dichlorides, a crystalline dichloride differing from products previously obtained in this reaction, together with small quantities of higher chlorine derivatives.—R. **Lantz**: The aryliminonaphthoquinones. The action of aromatic amines.—L. **Cayeux**: The submarine origin of the silex nodules and beds of chalk of the Paris basin.—Frédéric **Hermann**: The bundle of reversed folds of Valsavarenche and the prolongations of the Bagnes fan in the Franco-Italian Alps.—A. **Demolon**: The chemical constitution of brick earth.—Aug. **Chevalier**: The Leguminoseæ (Tephrosia) cultivated in tropical countries for capturing fish: their use and geographical distribution.—St. **Jonesco**: The action of mineral and organic acids combined with that of metallic sodium on the reddening of some flavones.—P. **Lasareff**: The sensation of the intensity of sounds according to the ionic theory of stimulation.—R. **Legendre**: The principle of a method for estimating the variations of dissolved carbonic acid.—A. H. **Roffo**: Cholesterol and hæmolysis.—W. **Kopaczewski**: Electrocapillary analysis of colloidal colouring matters.—Ch. **Porcher**: The various complexes, caseinate of lime + phosphate of lime, and their mode of behaviour towards rennet.—G. **Guittoneau**: The rôle of rennet and its mode of action in the manufacture of Gruyère and Emmenthal cheeses.—**Lemoigne**: The origin of the β-oxybutyric acid obtained by the action of micro-organisms. The non-autolysed *M. bacillus* contains an amorphous product, which can be isolated by chloroform and after saponification gives α-crotonic acid. The latter product may be considered as the mother substance of the β-oxybutyric acid.—Clément **Simon**, Ch. **Flandin**, **Seguin** and **Lecoq**: The action, *in vitro*, of pancreatic extracts on the Nagana trypanosome and *Spirochæta Gallinarum*.—**Robineau** and G. **Contremoulins**: The reactions on the human organism of prothetic or synthetic bone sterilised by boiling alcohol.

Official Publications Received.

Department of the Interior: United States Geological Survey. Water-Supply Paper 541: Surface Water Supply of the United States, 1922. Part 1: North Atlantic Slope Drainage Basins. Pp. vi+258+2 plates. (Washington: Government Printing Office.) 25 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 76, 1924. Pp. iii+444+21 plates. (Philadelphia.) 6.25 dollars.

Smithsonian Miscellaneous Collections. Vol. 77, No. 2: Explorations and Field-Work of the Smithsonian Institution in 1924. (Publication 2794.) Pp. iii+136. (Washington: Smithsonian Institution.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 293: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Ariz., 1921 and 1922. By Daniel L. Hazard. Pp. 99+5 plates. Serial No. 292: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Vieques, P.R., in 1921 and 1922. By Daniel L. Hazard. Pp. 98+4 plates. (Washington: Government Printing Office.) 15 cents each.

Experimental Vegetation: the Relation of Climaxes to Climates. By Frederic E. Clements and John E. Weaver. (Publication No. 355.) Pp. vii+172+15 plates. (Washington: Carnegie Institution.)

The Phytometer Method in Ecology: the Plant and Community as Instruments. By Frederic E. Clements and Glenn W. Goldsmith. (Publication No. 356.) Pp. vi+106+11 plates. (Washington: Carnegie Institution.)

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. 19: A Memorial to Alfred Goldsborough Mayor. Some Posthumous Papers of A. G. Mayor, relating to his Work at Tutuila Island and adjacent Regions; together with Reports of R. A. Daly, R. T. Chamberlin and C. B. Lipman on their Work in the same Connection. (Publication No. 340.) Pp. viii+217+56 plates. (Washington: Carnegie Institution.)

Cenozoic Gravigrade Edentates of Western North America, with Special Reference to the Pleistocene Megalonychinae and Mylodontidae of Rancho La Brea. By Chester Stock. (Publication No. 331.) Pp. xiii+206+48 plates. (Washington: Carnegie Institution.)

Contributions to Embryology. Vol. 16, Nos. 78-84. (Publication No. 361.) Pp. 276+32 plates. (Washington: Carnegie Institution.)

City of Norwich. The Report of the Castle Museum Committee to the Council, 1924. Pp. 25. (Norwich.)

Transactions of the Astronomical Observatory of Yale University. Vol. 3, Part 3: Theory of the Trojan Group of Asteroids. Conclusion of Chapter I, and Chapters II to VI: Development of the Theory and Applications. By Prof. Ernest W. Brown. Pp. 81-133. (New Haven.)

United States Department of Agriculture. Department Bulletin No. 1324: The Oviposition Response of Insects. By Charles H. Richardson. Pp. 18. (Washington: Government Printing Office.) 5 cents.

Forest Bulletin No. 60: Note on *Ainee*, *Artocarpus hirsuta*, Lamk. By C. Claude Wilson. Pp. ii+7+4 plates. (Calcutta: Government of India Central Publication Branch.) 7 annas; 9*d*.

Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 19: The Coal Resources of Union of South Africa. Vol. 2: The Inland Coalfields of Natal. By W. J. Wybergh. Pp. 180+6 plates. (Pretoria: Government Printing and Stationery Office.) 10*s*.

The Indian Forest Records. Silviculture Series, Vol. 11, Part 2: Contributions towards a Knowledge of Twisted Fibre in Trees. By H. G. Champion. Pp. v+70+13 plates. 2.8 rupees; 4*s*. 6*d*. Entomology Series, Vol. 11, Part 4: On some Indian Brenthidæ (Coleoptera). Part 1: Neue Brenthiden aus Britisch Indien und den anliegenden Gebieten, von Richard Kleine; Part 2: Notes on the Biology of the Brenthidæ, by Dr. C. F. C. Beeson; Part 3: Descriptions of the Larvæ of *Cerobates tristriatus* and *C. sexsulcatus*, and of the Pupa of *Cyphagogus corporaali*, by J. C. M. Gardner. Pp. ii+48+18+6+4 plates. 1.5 rupees; 2*s*. 3*d*. Chemistry Series, Vol. 11, Part 6: The Constituents of some Indian Essential Oils. Part 17. By Madyar Gopal Rau and John Lionel Simonsen. Pp. 8. 2 annas; 3*d*. (Calcutta: Government of India Central Publication Branch.)

The Royal Society for the Protection of Birds. Thirty-fourth Annual Report, January 1st to December 31st, 1924; with Proceedings of Annual Meeting, 1925. Pp. 94. (London: 82 Victoria Street, S.W.1.) 1*s*.

Proceedings of the South London Entomological and Natural History Society, 1924-25. Pp. xix+142+8 plates. (London: Hibernia Chambers, London Bridge, S.E.1.) 12*s*. 6*d*.

Field Museum of Natural History. Zoological Series, Vol. 12, No. 8: Two new Birds from Peru. Reports on Results of the Captain Marshall Field Expeditions. By John T. Zimmer. (Publication 228.) Pp. 101-109. (Chicago.)

The Journal of the Royal Agricultural Society of England. Vol. 85, 1924. Pp. 12+447+clviii+x+20. (London: John Murray.) 15*s*.

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich. Read at the Annual Visitation of the Royal Observatory, 1925, June 6. Pp. 21. (Greenwich.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 108: Seismische Registrierungen in De Bilt. 10, 1922. Pp. xvi+47. (Utrecht: Kemink en Zoon.) 0.80 f.

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1924. (No. 73.) Pp. 146. (Marlborough.) 3*s*. 6*d*.

Aeronautical Research Committee: Reports and Memoranda. No. 933 (Ae. 154): Forces and Moments (including those due to Controls) on a Model Fairey "N4" Flying Boat *Atalanta* at various Angles of Yaw. By H. B. Irving and A. S. Batson. (A.2.a. Stability Calculations and Model Experiments, 87—T. 1974.) Pp. 14+12 plates. 1*s*. net. No. 941 (M.N. 8): Measurement of Vertical Currents in the Lowest Layers of the Atmosphere during Sea-Breezes. By J. Durward. (A.5. Meteorology, 103—T. 1887.) Pp. 5+3 plates. 6*d*. net. No. 952 (Ae. 171): Further Experiments on Honeycomb Radiators. By Dr. R. G. Harris and L. E. Caygill. (A.3.k. Miscellaneous 49—T. 1997.) Pp. 20+12 plates. 1*s*. 3*d*. net. No. 958 (Ae. 177): Lift and Drag of two Aerofoils measured over 360° Range of Incidence. By C. N. H. Lock and H. C. H. Townsend. Pp. 5+4 plates. 6*d*. net. (London: H.M. Stationery Office.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 505: Critical Potentials associated with Excitation of Alkali Spark Spectra. By F. L. Mohler. Pp. 165-191. (Washington: Government Printing Office.) 10 cents.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Jaarverslag 1924. Pp. 22. (Weltevreden: Landsdrukkerij.)

Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1924. Pp. 11. (Salisbury, Southern Rhodesia.)

British Empire Exhibition, 1925. Official Guide. Edited by G. C. Lawrence. Pp. 128. (London: Fleetway Press, Ltd.) 1*s*.

Egyptian Government Almanac for the Year 1925. Pp. viii+300. (Cairo: Government Publications Office.) 5 P.T.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 105 Jahresversammlung vom 1 bis 4 Oktober 1924 in Luzern. 1 Teil. (Actes de la Société Helvétique des Sciences naturelles. 105e session annuelle du 1er au 4 octobre 1924 à Lucerne. 1re partie.) Pp. 252+60. (Aarau: H. R. Sauerländer et Cie.)

Diary of Societies.

SATURDAY, JUNE 20.

ASSOCIATION OF WOMEN SCIENCE TEACHERS (Summer Meeting) (at Birmingham University), at 10.45.—Business Meeting.—At 11.30.—Dr. Shakespear: Colour (Lecture).

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children Section) (in Bio-chemical Laboratory, Cambridge), at 2.30.—Dr. Kay and Dr. Vines: Bone Formation and Experimental Rickets.—At 4.45.—Dr. J. F. Gaskell: The Relationship of Experimental Pneumonia in Rabbits to the Pneumonias of Childhood.

MONDAY, JUNE 22.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Summer Meeting) (at Queen's Hotel, Birmingham), at 9.30 A.M. (Also on June 23 and 24.)

ROYAL IRISH ACADEMY, at 4.15.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—Prof. J. C. McLennan, Lord Rayleigh: The Aurora and its Spectrum. Chairman: Sir Ernest Rutherford.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

TUESDAY, JUNE 23.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Lt.-Col. J. Cunningham: Some Factors in Racial Immunity and Susceptibility to Disease.

WEDNESDAY, JUNE 24.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. W. J. Sollas: On a Sagittal Section of the Skull of *Australopithecus africanus*.—D. Parkinson: The Faunal Succession in the Carboniferous Limestone and Bowland Shales at Clitheroe and Pendle Hill.—Janet M. M. Dingwall: On Cyathoclisia, a New Genus of Carboniferous Corals.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. I. D. Suttie: An Irrelevant Accretion to the Freudian Theory.

THURSDAY, JUNE 25.

ROYAL SOCIETY, at 4.30.—D. H. Black: β-Ray Spectra of Thorium Disintegration Products.—Miss C. F. Elam: Tensile Tests of Crystals of an Aluminium Zinc Alloy.—Dr. G. Shearer: On the Distribution of Intensity in the X-Ray Spectra of Certain Long-Chain Organic Compounds.—C. F. Jenkin: High Frequency Fatigue Tests.—L. W. Bryant and D. H. Williams: An Investigation of the Flow of Air around an Aerofoil of Infinite Span. With an Appendix by Prof. G. I. Taylor, Note on the Connexion between the Lift of an Aerofoil in a Wind and the Circulation round it.—*To be read in title only*:—Prof. T. H. Havelock: Wave Resistance: the Effect of Varying Draught.—Prof. C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface Tension, Part III.—W. H. George: An Electrical Method for the Study of Impact applied to the Struck String.—F. H. Constable: The Mechanism of Catalytic Decomposition.—S. A. Emerson and Dr. L. C. Martin: The Photometric Matching Field, II.—G. S. Adair: Partial Osmotic Pressures and Membrane Equilibria.—Miss Mary W. Porter: A Contribution to the Study of the Optical Properties of Mixed Crystals.—H. Gregory and C. T. Archer: Experimental Determination of the Thermal Conductivities of Gases.—D. B. Deodhar: On the Atmospheric Radio-activity and Indian Weather.—Prof. J. R. Partington and A. B. Howe: The Ratio of the Specific Heats of Hydrogen.—A. Cary and Dr. E. K. Rideal: The Behaviour of Crystals and Lenses of Fats on the Surface of Water. Part I.—G. H. Henderson: The Capture and Loss of Electrons by α-Particles.—Dr. A. S. Parkes: The Effects on Fertility and the Sex-ratio of Sub-Sterility Exposures to X-rays.—R. N. Chrystal: The Genus Dreyfusia (Order Hemiptera, Family Chermesidæ) in Britain and its Relation to the Silver Fir.—T. Moran: The Effect of Low Temperatures on Hens' Eggs.—And other papers.

FRIDAY, JUNE 26.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. A. Russell: The Electrostatic Capacity of Two Spheres when Touching One Another.—Miss S. Marshall and J. O. C. Vick: An Investigation of the Control Conditions under which Newton's Law is valid for the Emission of Heat from Electrically Heated Wires.—I. Jones: Condensation of Nuclei Produced by the Illumination of Air-halogen Mixtures.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (at Manchester University).—Dr. H. P. Fairlie and others: Discussion on Chloroform.—S. R. Wilson and Dr. S. McSwiney: Animal Demonstration showing Effects of Adrenalin Injections during Ether and Chloroform Anæsthesia.