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Work and Influence of the Royal Botanic Gardens, Kew.

COAL, oil, iron and steel enter so largely into the working of the complicated civilisation of the present that it is apt to be overlooked that they are but the tools for collecting, distributing, elaborating, protecting and too often destroying the organic products on which the life of man, his culture and most of his comforts depend. Directly or indirectly, these products are the gift of the living green mantle of the earth. The spread of population that has taken place concurrently with the evolution of modern industry has brought about great, and is likely to bring about still greater, changes in the earth's vegetation. Some of those transformations, such as the displacement of the native flora of prairie lands by cereals and other crops, are inevitable and, from the human point of view, beneficial; others, like the reckless destruction of forests in many parts of the world, have wasted the present and heavily mortgaged the future. The sooner the problem of ensuring a rational utilisation of the vegetation of the earth is faced in more organised fashion than at present the better.

It is of peculiar importance to the British Empire, for no other power holds such vast estates, with every variety of physiographical and other conditions, and almost boundless potentialities of production. These potentialities can be developed to the best advantage only on a foundation of exact knowledge of all the conditions, and one of the most important elements of this foundation is a thorough scientific survey of the vegetation of the Empire. Although the desire for increase of knowledge of plants was stimulated by the travels and voyages of discoveries from the fifteenth century onwards, and their resulting introductions of new plants and products into Europe, a scientific survey was impossible until a rational system of nomenclature was devised by Linnæus, about the middle of the eighteenth century. Thereafter the botanical survey of the Empire began and has been in progress ever since.

In British colonies and tropical possessions the benefits expected from the introduction of foreign, and the improvement of native, plants, and the need of centres where such plants could be experimentally cultivated, led to the foundation of botanic gardens in the West Indies, India, Australia, the Straits Settlements and Ceylon. These and other overseas gardens have played a very useful part in the botanical survey of the Empire, but it may be doubted if the practical importance of these institutions is appreciated as it should be, for in too many cases their history is one of cramped finances, under-staffing and scanty equipment.

Still, in founding them at all the governments concerned showed more enlightenment than was evident in the home government for many a year afterwards, for while this activity was being shown abroad the home government remained indifferent. Fortunately, this official neglect was counterbalanced by the interest in botany shared by Royal personages and men of position and wealth, and it is to such interest that the British Empire owes the foundation of the Botanic Garden that more than all the others has contributed to our knowledge of the Empire's vegetation.

The small Physic Garden, which Princess Augusta, with the advice of the Earl of Bute, formed at Kew in 1760, was greatly enlarged after her death in 1772 by her son, George III., and Joseph Banks—not long returned from his famous voyage with Cook—placed in advisory charge. For almost half a century thereafter, the king royally supported Banks in his schemes for the enrichment of the Royal Botanic Garden—as it had now become—and the botanical exploration of the lands beyond Europe. In addition to the support of the king, the interest, wealth, and influence in scientific circles of Sir Joseph Banks, the impersonal advantages of its geographical position contributed to the early pre-eminence of Kew. In tropical gardens the difficulties in controlling temperature restrict the introduction of plants to those of similar climates, while in the investigation of the vegetation of the territories they serve, most of them were and are embarrassed by a wealth of material far beyond their means to work out unaided. Here Kew was—and is—of signal service, for it could introduce plants from and to all parts, while the comparative poverty of the British flora left the Garden all the more free to extend its interests and help beyond the British Isles.

Natural advantages, however, avail not without personality and means, as Kew discovered with the passing of the king and Sir Joseph Banks in 1820. For the next twenty years the Royal Gardens declined almost to extinction, from which they were rescued only by the interest of the young Queen Victoria and an agitation against their proposed abandonment that led to a committee being appointed to advise on the future of the Gardens. The committee—which included Lindley and Paxton—commented rather severely on the lack of unity of purpose and of system in the control of the overseas gardens and advocated the placing of them all under the control of a central National Botanic Garden as the best means of coordinating the investigation of the vegetation of the Empire and of applying such investigation to medicine, commerce, agriculture, horticulture and industry. Although the wisdom or even the feasibility of placing all the gardens of the outer lands under the official control of a central garden may be doubted, there can be no question of the advantages of co-operation and co-ordination, and there is still a vast field for cultivating both.

Although the Report of the Committee did not result in the establishment of an Imperial Botanical Survey, it brought about the transformation of Kew from a private Royal Garden into a public one, and the appointment of the elder Hooker as its first director. Since then Kew has, thanks in no small degree to the personality of its directors, proved a most valuable asset to the British Empire. On the purely scientific side, and considering only the Empire lands, Kew can point to the published floras of Australia, New Zealand, Hongkong, the Malayan Peninsula, Ceylon, India and most of its Provinces, Mauritius, the Cape, tropical Africa and the West Indies as amongst the fine fruits of its botanical leadership. On the applied side its influence on horticulture and on the introduction and cultivation of economic plants has been far-reaching and profound. Of the latter the vast growth of the rubber industry is a notable instance. It may be doubted, however, if the great practical importance to the Empire of the scientific activities of Kew and the scope for extending these are sufficiently appreciated.

Possibly one reason for this is the unobtrusive way in which the work has been carried on and the reticence practised in publishing information as to the Gardens' activities. It is, therefore, a move in the right direction that the old practice—obsolete for so many years—of publishing a review of the year's work, has been recommenced. This review, which appears under the guise of Appendix II., 1925, of the Bulletin of Miscellaneous Information, gives within 31 pages a concentrated account of the work of the Gardens during 1924. Almost every page mirrors the worldwide range of Kew, for whether it be the Gardens proper, the Museums, the Jodrell Laboratory or the Herbarium and Library, there is scarcely a land between the poles that does not give or take.

The offerings, in fact, have been for so many years in excess of the means of dealing with them that Kew has suffered from chronic indigestion. While it is good to learn that some relief has been given to this condition by a temporary addition to the Herbarium staff, it is as well to recognise that this is merely palliative. Proper treatment of the condition involves a strengthening of the whole organisation for botanical survey work—in the widest sense—throughout the Empire. The wider aspect of the problem which forced itself upon the attention of the Committee of 1838, was again examined by the Imperial Botanical Conference of 1924, whereat many excellent suggestions were advanced.

The extent to which these suggestions are likely to bear fruit will depend largely on the realisation by the home and overseas governments of the great practical importance of the Survey and on the recognition by those who have made and are making fortunes in jute, tea, cotton and other textiles, soap and such-like products, of what they owe to botanical investigations. As Dr. Burtt Davy pointed out at the Conference, the home government has good reason to give generous aid to the Survey, as England depends so much on the overseas parts of the Empire for raw products and foodstuffs. Yet the total annual expenditure on Kew is little more than equal to the interest on the proposed government guarantee for the British Empire Exhibition. If England can find such a guarantee for an Exhibition so largely concerned with the organic products of the Empire, it should surely be possible to allow a more liberal endowment than is at present available for the investigation of the ultimate source of all such products. The support of the Survey should appeal no less to the overseas governments as a fruitful aid in the development of their vegetative resources and so of their populations and products. Yet at Kew, the botanical centre of the Empire, only India and the combined West African colonies are represented on the scientific staff by a single botanist each.

The fact that most of the botanical gardens of the Empire are government institutions is not an unmixed advantage, for government financial departments are apt to judge them rather too much by the irrelevant test of direct revenue and to treat them as mere luxuries to be reduced when opportunity offers, while the public scarcely thinks of them as requiring financial aid like universities, medical schools and hospitals. Governments may reasonably be expected to provide for an increase in staff and equipment and the institution—where it is not already in existence—of some system of study leave, such as the Indian scientific services enjoy, to enable members of the scientific and horticultural staffs to enlarge their experience and increase their usefulness.

But beyond such provision as any government within the Empire is likely to give, there remains abundant scope for private aid in the endowment of travelling fellowships, of exploration of the less known parts of the Empire, of lectureships on various aspects of the vegetation of the Empire, of libraries, of museums, of laboratories and of publications. For the exercise of such public-spirited liberality the Royal Botanic Gardens, Kew, which owe their enlarged foundation to the enlightened munificence of an English king, stand as a splendid stimulus and example.

Egyptian Mathematics.

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.

I.

PROF. PEET'S beautiful book is written for the Egyptologist and the mathematician, but not only for them. It is also for the man in the street—in such a street as runs through any university town; for the Rhind papyrus is one of the ancient monuments of learning. The famous scroll was bought in Luxor in 1858 by a Scottish lawyer and antiquary, from whose keeping it passed into that of the British Museum. There, in 1867, Lenormant examined it and referred it to the XIIth dynasty; Birch, and Brugsch the lexicographer, again examined and in part described it; and Eisenlohr (a colleague of Moritz Cantor's in Heidelberg) published a full and useful description,[1] based on facsimiles lent by the Museum—" a courtesy which he repaid by publishing a tracing of them without authority." The Museum issued an almost perfect facsimile in 1898, with an introduction by Sir E. A. W. Budge (cf. NATURE, vol. 59, p. 73); and at various times the papyrus has been studied by many scholars, by Hultsch, Cantor, and Lepsius, Griffiths and Rodet, Favaro, Gino Loria and others. Prof. Peet is a born Egyptologist; he has made himself a mathematician; he has "combined his information." His labours crown the exhaustive investigation of the papyrus, and he gives us its whole story in the most attractive and most readable form; he might have given us, perhaps, a fuller bibliography.

As it lies in the British Museum the papyrus is in two parts with a gap between; some one (Prof. Peet does not tell us who) had the good fortune and the insight to discover that the gap was in part filled up by certain fragments in the possession of the New York Historical Society, once the property of Edwin Smith, and probably obtained by him together with a famous medical papyrus which bears his name. These New York fragments help to complete a table of fractions of which we shall speak directly, a table which is of cardinal importance for the understanding of the whole work.

The Rhind papyrus was written under a certain Hyksos king who reigned somewhere between 1788 and 1580 B.C., but the scribe states that he copied an

[1] "Ein mathematische Handbuch der alten Ägypten," 1877.

older document of the XIIth dynasty, in a reign which can be more precisely dated as between 1849 and 1801 B.C.—some twelve or thirteen centuries before Pythagoras; this date is much the same as that of other important mathematical papyri, such as the Berlin fragment and the Moscow papyrus. Whether in its time it was a great work or a minor one, a compendium for the scholar, a manual for the clerk, or even a lesson-book for the schoolboy, we do not know; but a popular or standard work of its kind, its re-issue after more than a hundred years shows it to have been. Were it only an elementary schoolbook it would still illustrate a saying of De Morgan's—we have it in the preface to his work on early "Arithmetical Books"—that "the most worthless book of a bygone age is worthy of preservation"; we may be thankful for this one, over and over again.

According to our own vague impressions, we are apt to minimise or to magnify what the ancients, and not least what the Egyptians, may or must have known; we are seldom justified, we must always be cautious, in saying that the Egyptians (or the Greeks, as the case may be) did *not* know this or that. At the very least this papyrus tells us many things which they did know, and shows what were doubtless their common ordinary ways of solving their problems. But mathematics is so curious a thing, the gift of numbers is so singular a mental faculty, that I should be loath to believe that there were not men in ancient Egypt who could do far more difficult calculations than any which this papyrus reveals, and do them by other methods than are set forth here.

How much earlier than this XIIth dynasty papyrus must we go to find the beginnings of Egyptian mathematics? This is one of the questions discussed, all too briefly, by Prof. Peet in his fascinating introduction. Even in the first dynasty a notation was in vogue up to the sign for a million; under the IVth dynasty we find the same land-measures in use as are employed in the Rhind papyrus: the origin of learning, the beginnings of science and of the arts, recede from us the more we follow them. But so far as we can see, and so far as Plato and other Greeks have told us, the ancient science of the Egyptians ran its long course on narrow lines. There may have been dreamers among them, but (unlike Joseph) they did not tell their dreams; what we know of their wisdom the scribes have told us, and the scribes were practical men. We have no trace in Egypt of such speculative mathematics as occupied the School of Pythagoras, no discussion of first principles, no philosophy like Plato's, of which mathematics was a part. Even the Rhind papyrus is scarcely a treatise at all; it is a collection of examples, and the examples are of a strictly practical kind. For this very reason they seem strangely familiar to us; they are everyday, world-wide problems, of so many loaves to so many men and such like; they are often all but word for word the selfsame exercises which we and our children have done at school. They seem to me just such simple calculations, "combining amusement with instruction," as Plato says "the sons of gentlemen should learn, as they do in Egypt."

The Egyptologist has learned much in the last few decades, and the mere translation of the text is far more certain in Prof. Peet's hands than in those of its first students. There is a curious instance of the early difficulties of the translator—Prof. Peet only half relates or merely hints at it. The text of a certain problem, all but the last in the book, led Eisenlohr to assert that the powers of a number had specific and curious Egyptian names—the scribe, the cat, the mouse, etc. Favaro, for one, was suspicious; he called this "una denominazione così strana da far dubitare che l' Eisenlohr abbia rettamente interpretato a questo punto il papiro"; and Cantor said he could neither verify nor disprove the statement. Léon Rodet, reading the *Liber Abaci* of Leonardo Pisano (or Fibonacci, as we usually call him), was struck by the resemblance of the series to a problem there: Septem vetulae vadunt Romam; quaelibet habet burdones (i.e. *donkeys*) septem, etc. Why, it is just the medieval setting of our own immortal "As I was going to St. Ives"; and so they had it in Egypt also: "[In such a town] were seven scribes [2]; each scribe had seven cats; each cat caught seven mice"; and so on.

The Egyptian notation was a decimal one, as was that of all ancient peoples save the older Babylonians, but the Egyptians had signs only for the unit, for 10, 100, and so on up to 100,000, each of these signs being repeated the required number of times; it follows from this that addition, or "putting on," and subtraction or "breaking off," were merely mechanical processes. Multiplication and division were performed under strict limitations. To multiply by 10 was easy, for it only meant turning the unit-symbols into 10's, and so on; yet this easy method was not always employed. With very few exceptions the Egyptian multiplied by two, and by no other number: his multiplication table, the multiples which he knew by heart, would seem to have stopped at two-times. He employed the processes of *duplication* and *dimidiation*, rather than of multiplication and division; and books of arithmetic maintained the same distinction at least up to the sixteenth century. He kept on doubling; and he could

[2] Prof. Peet now translates "seven houses."

then pick out, or tick off, from the successive products any multiple he pleased. Thus to multiply 7×11, he would write down

/	1	7
/	2	14
	4	28
/	8	56
	—	—
	11	77

He added together the once, twice, and eight times: we add together the once and the ten times; that is wellnigh all the difference. Moreover, when we do our sums by "practice," we are using a very ancient method and doing them almost exactly as the Egyptians did.

Why, when he started with a symbol for 11, consisting of a unit and a ten, he did not at once write down seven units and seven 10's, and so obtain his symbol for 77, we do not know—and we are left wondering; but the method here exemplified is the one which runs all through the book. It seems impossible to believe that the old mathematician was really limited to this cumbrous method; and it is tempting, therefore, to suppose that he inculcated it for a deeper reason. Rodet believes that his purpose was to demonstrate a theory of proportion, to show that two quantities retain the same relation to one another, whatever identical operations of multiplication and division they have both undergone.

The above method of multiplication could not go far, and the converse process of division could not be effected at all, without constant use of fractions; and these the Egyptian handled with extraordinary skill, though again his limitations were severe. While he could easily express any whole number, he had no notation for fractions (with the single exception of $\frac{2}{3}$) other than as aliquot parts, *i.e.* as fractions the numerator of which is unity—fundamental fractions, as Schiaparelli called them; all other fractions had first of all to be reduced to these, and how to do so, how to reduce any fraction to a series where each has unity for its numerator, is a problem which has not yet ceased to interest mathematicians. The Greeks (with certain exceptions) did precisely the same thing; thus Archimedes writes $\frac{1}{2}$, $\frac{1}{4}$, for $\frac{3}{4}$, and Hero writes $\frac{1}{2}$, $\frac{1}{17}$, $\frac{1}{34}$, $\frac{1}{51}$ when he wants to express $\frac{31}{51}$; moreover, the Greeks had special signs for $\frac{1}{2}$ and $\frac{2}{3}$, but for no other fractions.

The Egyptian kept by him a table of these equivalent fractions, which table, as Cantor says, we can only suppose to have grown slowly into shape as the result of protracted labours. How it was achieved at all is a question elaborately discussed by Cantor, Eisenlohr, Hultsch, Griffiths, and others, and now by Prof. Peet; but there seems to be no clear and certain answer yet, and Cantor confesses openly to failure. The Rhind papyrus carries the list from $\frac{2}{5}$, $\frac{2}{7}$, etc., as far as $\frac{2}{101}$. $\frac{2}{5}$ was easily resolved into $\frac{1}{3}+\frac{1}{15}$; $\frac{2}{7}$ into $\frac{1}{4}+\frac{1}{28}$, etc.; but some of the resolutions were of necessity complicated, *e.g.* $\frac{2}{61}=\frac{1}{40}+\frac{1}{244}+\frac{1}{488}+\frac{1}{610}$; or $\frac{2}{89}=\frac{1}{60}+\frac{1}{356}+\frac{1}{534}+\frac{1}{890}$. The papyrus explains them all, one by one, for example:—

Divide 2 by 13:

$$1\tfrac{1}{2}+\tfrac{1}{8} \text{ is } \tfrac{1}{8}. \quad \tfrac{1}{4} \text{ is } \tfrac{1}{52}. \quad \tfrac{1}{8} \text{ is } \tfrac{1}{104}.$$

Working out:

	1	13	
	$\frac{1}{2}$	$6\frac{1}{2}$	
	$\frac{1}{4}$	$3\frac{1}{4}$	
/	$\frac{1}{8}$	$1\frac{1}{2}+\frac{1}{8}$	/
/	$\frac{1}{52}$	$\frac{1}{4}$	/
/	$\frac{1}{104}$	$\frac{1}{8}$	/.

13 has been split up into parts, first by successive divisions by 2, afterwards by the scarcely more difficult operation of taking $\frac{1}{13}=1$, and therefore $\frac{1}{52}=\frac{1}{4}$. The next step is tacitly assumed: namely, to pick out from the divisional parts of 13 such as, taken together, amount to 2; and the corresponding fractions of 1, standing opposite to them, are the series required.

It may well be that what is here set forth does not purport to be an explanation of the method, but merely a proof or verification of the result stated; so also in many other problems with which the papyrus deals —the answer is given, and the working shown is that required to check or confirm it. Prof. Peet, however, thinks that the setting out of the proof gives us a clue to the way in which the result was actually obtained; the method was clearly one of trial and error. The Egyptian "had grasped the fact that the problem consisted in breaking up 2 into the sum of several quantities, each of which would divide without remainder into the given denominator"; and accordingly, Prof. Peet shows us, alongside of the resolved fractions, the corresponding resolutions of 2—as being the first step towards the discovery of the former.

We, I imagine, would proceed otherwise. We should probably begin by multiplying the numerator and denominator of our fraction $\frac{2}{a}$ by some number, greater than $\frac{a}{2}$, until we found the new numerator resolvable into parts, each a convenient sub-multiple of the new denominator. Thus $\frac{2}{13}=\frac{2\times 7}{13\times 7}=\frac{13+1}{13\times 7}=\frac{1}{7}+\frac{1}{91}$; and this seems a simpler result than that arrived at by the Egyptian; it seems to prove that this was not the Egyptian's way. It is curious that this is the very result we get by the method shown in the late Greek papyrus of Akhmim.[3]

But the more we look at the Egyptian's table of resolutions the more satisfactory and even elegant does it appear; it is only very seldom that we can suggest a better alternative. There is no simpler resolution, for example, of $\frac{2}{97}$ than $\frac{1}{56}+\frac{1}{679}+\frac{1}{776}$, which is what the table gives. For $\frac{2}{35}$ we might prefer $\frac{1}{20}+\frac{1}{140}$ to $\frac{1}{30}+\frac{1}{42}$, which latter is what the Egyptian gives; but he is probably right in avoiding the higher denominator. In this case he has resolved 2 into $\frac{7}{6}+\frac{5}{6}$, or, as he writes it, $1\frac{1}{6} \cdot \frac{1}{2}+\frac{1}{3}$: he adds a note to show that he realised he was dealing with $7\times\frac{1}{6}$, and $5\times\frac{1}{6}$. It is one of the cases which seem to show that he was not hampered by lack of skill, so much as by his strictly limited and conventional notation.

The last case of all, namely, $\frac{2}{101}$, is an interesting one; the solution given is $\frac{1}{101}+\frac{1}{202}+\frac{1}{303}+\frac{1}{606}$, a form of resolution differing from any other in the long list, for here, and here alone, one of the fractions is just one half of, and thus has the same denominator as, the fraction to be resolved. Prof. Peet remarks that "mathematically the result is surprising and disappointing; it may be surmised from this feeble ending that the mathematician was here at the extreme range of his ability." I do not think so; the solution seems to me an elegant one, and what is more, *there is no other* which does not involve very high denominators; the simplest, and much the simplest alternative which I can discover, is $\frac{1}{60}+\frac{1}{404}+\frac{1}{1515}$, but this last denominator is much higher than any other which the table admits or contains.

From the Table of Resolutions of $2/(2n+1)$, we pass to problems where so many loaves have to be divided among ten men; the rule as to aliquot parts is still adhered to, and the problems are little more than simple exercises on the preceding table. From these we go on to somewhat more difficult but closely related exercises, involving the addition and subtraction of fractions; these are what are called the *skm*, or *sekhem*, problems, *i.e.* problems of *completion*. "Democritus spent a quarter of his life as a boy, a third as a youth, a fifth in manhood, and he has been an old man for thirteen years; how old is Democritus?" This is a well-known problem in the Greek Anthology; I take it to be a typical *sekhem* problem. Those which our papyrus gives are in plainer form. For example, given the series $\frac{1}{4}+\frac{1}{8}+\frac{1}{10}+\frac{1}{30}+\frac{1}{45}$, we are asked to complete it to $\frac{2}{3}$; in other words, to subtract it from this latter fraction. Most of the working is omitted. The fractions are first replaced by the numbers $11\frac{1}{4} \cdot 5\frac{1}{2} + \frac{1}{8} \cdot 4\frac{1}{2} \cdot 1\frac{1}{2} \cdot 1$, which are numerators corresponding to a common denominator 45. The complete series is then stated as follows:

$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{9}$	$\frac{1}{10}$	$\frac{1}{30}$	$\frac{1}{40}$	$\frac{1}{45}$	$\frac{1}{3}$
$11\frac{1}{4}$	$5\frac{1}{2}+\frac{1}{8}$	5	$4\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$	1	15

"making 1,"

and $\frac{1}{9}+\frac{1}{40}$ is seen to be the required "completion" of the original series to the sum of $\frac{2}{3}$. The phrase "common denominator" is, of course, modern, for the Egyptian has no equivalent word; nor indeed was it precisely a "common denominator" which he sought and used. In the above example the common denominator would be 360; the Egyptian was content with the denominator 45, for, though the corresponding numerators were often fractional, they were simple fractions such as gave him no trouble to employ.

Rodet has emphasised more than Prof. Peet the distinction between this operation and ours; and he has shown in a very interesting way how what was precisely the old Egyptian method survived in Jewish and Moorish arithmetic. The Hebrew *môré*, the "ruler" or "guide," and the Arabic *mokhraj*, or "block"—out of which what we require may be hewn—had a wider meaning than our "common denominator"; it was anything to parts of which our fractions may be considered equivalent—even the fraction $\frac{1}{2}$ was looked upon as having 2 for its *mokhraj*. We do the same thing, though we forget we do so, every time we write or think of $\frac{1}{2}$—which, by the way, is a very different concept from 0·5. When we speak of $\frac{1}{2}$, we mean that something, that "fraction," which has the same relation to 1 that 1 has to [our *mokhraj*] 2. As Rodet puts it, "il est bien certain qu'Aahmesu ne 'réduisit ses fractions à un dénominateur commun,' mais que, comme on l'a fait après lui pendant vingt-six et trente siècles encore, il choisissait un nombre, bloc extractif, fonds commun ou comme on voudra l'appeler, d'où il puisse tirer toutes ces fractions, soit comme ses successeurs à l'état d'entiers, soit comme il s'en contentait à l'état d'*à peu près entiers*, mais, dans ce cas, avec une fraction d'expression simple; et c'est sur les substituts ainsi obtenus pour ses fractions qu'il opérait." If our method has any advantage it is merely one of arithmetical technique; the older arithmetician saw as deep, if not deeper, into the heart of the problem.

It seems to me that we may help ourselves to understand the Egyptian way of dealing with fractions if we take a hint from Herodotus, and remember that the Egyptian did his counting with *pebbles*. I can imagine him pondering over a handful of pebbles, and trying to divide it into aliquot parts; then, if necessary, taking more and more similar handfuls, until he got at last a suitable and satisfactory *mokhraj*.

D'ARCY W. THOMPSON.

(*To be continued.*)

[3] Cf. Heath's "A History of Greek Mathematics," vol. 2, p. 543.

Nature and Mind.

(1) *Prolegomena to an Idealist Theory of Knowledge.* By Prof. Norman Kemp Smith. Pp. xiii+240. (London: Macmillan and Co., Ltd., 1924.) 10*s.* 6*d.* net.

(2) *Modern Theories of the Unconscious.* By Dr. W. L. Northridge. Pp. xv+194. (London: Kegan Paul and Co., Ltd., 1924.) 8*s.* 6*d.* net.

(3) *The Nature of Laughter.* By J. C. Gregory. (International Library of Psychology, Philosophy and Scientific Method.) Pp. v+241. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 10*s.* 6*d.* net.

(4) *The Beautiful.* By Henry Rutgers Marshall. Pp. x+328. (London: Macmillan and Co., Ltd., 1924.) 15*s.* net.

(5) *The Philosophy of Music.* By Dr. William Pole. Sixth edition, with an Introduction by Edward J. Dent, and a Supplementary Essay by Dr. Hamilton Hartridge. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxiv+342. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1924.) 10*s.* 6*d.* net.

THE common presumption of the mutual indifference of philosophy and science has never been true of the masters. Every great creative mind in philosophy has been responsive to the scientific situation and method of his day, and most of those who have formulated the decisive hypotheses of the various sciences have recognised the scientific importance of those inquiries into the presuppositions of knowledge or into the most general features of reality, which are the proper business of philosophy. But though the greater movements of both disciplines have thus influenced each other, it is no doubt true—and part of the price we pay for our instrument of specialised investigation—that the detailed working out of these dominant conceptions in each field has proceeded with relatively little reference to the other; and that from time to time there has been evident a failure of adjustment and harmony.

One of the significant elements in our contemporary position is that both sides seem to be increasingly conscious of the loss involved in such a failure, so that there is a well-marked effort to co-ordinate the results of both lines of inquiry. Of this tendency, so far as it touches philosophy, Prof. Kemp Smith's important essay in the theory of knowledge (1) is the latest and a most instructive example: and although it is a technical and even a difficult book, it may well be recommended to the attention of those who wish to see how philosophical discussion is affected by and shapes towards current scientific thought. Prof. Kemp Smith's problem, of course, is primarily philosophical, and its orientation to scientific interests is incidental. He is concerned with the relation of the long-continuing idealist tradition to the resurgent and perhaps now dominant mode of philosophical realism. But this realism is itself a product of the impact of science on philosophy, or (more accurately) it represents in philosophy, now as always, the preoccupation with the distinctively scientific problem and point of view. In dealing with it Prof. Kemp Smith avails himself, though as buttresses rather than as foundations of his conclusions, both of Dr. Whitehead's philosophy of Nature, and of the physiological researches of Dr. Head and Sir C. S. Sherrington, while one important section of his argument is governed by certain general biological considerations.

The title of the book is elliptical. It offers not what would ordinarily be called an idealist theory of knowledge, but a theory of knowledge thoroughly realist in temper as a prolegomenon to an idealist metaphysic. Of this latter, nothing is here given except brief indications at the beginning and end of the book. But these are sufficient to show the relation which the writer intends his theory to bear to idealist doctrine. What he aims at doing is, in a word, to reform and strengthen its main defences which (he thinks) have been badly shattered by realist criticism.

The crucial issue for idealism, Prof. Kemp Smith holds, is as to the status in reality of the great human interests of knowledge, morality, art and religion. Now idealism has been wont to rest the defence of these interests upon a particular view of the relation of subject and object in knowledge, which it has reached by an analysis of the implications of the intelligibility of the world. It has supposed that such an analysis would show that the world of our experience depends for certain of its ultimate features on the constitutive character of its relation to mind: and that if reality thus accepts the lead of mind in the process of knowledge, the way is open to us to hold that it will do so also in the further constructions which mind puts upon it.

Prof. Kemp Smith does not wholly dissent from this approach. It is essential to his view to hold to the correlation of mind and Nature, in virtue of which the categories or *a priori* principles of explanation employed by the mind are interpretations of the real world. He holds, too, that it is by these categories that we are led to the further ideal determinations of our higher spiritual interests. But he clearly believes that much of the familiar statement of this argument is vitiated by an assumption that this correlation implies that mind somehow dictates to Nature, so that the idealist version of the *a priori* is entangled in the embarrassment of subjectivism. Against all theories of this sort he accepts as valid the realist principle that if knowledge is to be genuine, it must be knowledge of an independent reality, which the mind in knowing neither makes nor alters. His agreement with that view is expressed in a full critical statement first of the attractiveness and then of the defect of the whole doctrine of "representative perception."

Prof. Kemp Smith seeks, therefore, to free idealism from this subjectivist implication. The escape lies in taking Nature as an authentically independent system; and from that viewpoint finding a new and thoroughly objective deduction of the categories. If Nature is such a system, space and time, its fundamental features, must be independently real; and it is as such, Prof. Kemp Smith holds, that they do, in fact, disclose themselves to the mind. They are not forms imposed by the mind, nor are they constructions or elaborations of sense data of another sort. But they reveal themselves not indeed through but in terms of sense experiences or "sensa" of various kinds: and the apparent dependence of these sensa (as in the secondary qualities) on different apprehending minds raises a question of their objective character. Prof. Kemp Smith's solution is that the sensa though "private," *i.e.* occurring in connexion with particular physical and physiological conditions at particular points in space and time, are not "subjective" but are capable of statement as events in an objective order, so that their interpretation as such may be taken to yield knowledge of that order. Finally the categories, through the fundamental categories of totality and necessitation, are involved in our intuition of space and time. They, too, therefore, are directly apprehended as constituent of Nature. In themselves they are formal and problematic, predetermining nothing, but dependent for their concrete significance on our experience of the objective order.

Here, then, so to say, the defences of idealism are reversed. If the metaphor of prescription is in order at all, it is Nature which prescribes to mind, not mind to Nature. But whatever the priority, at least mind remains integral to Nature and our dealings with reality are face to face. What measure of idealism may rightly be based upon a so little pretentious theory of mind is not yet declared. It is possible that Prof. Kemp Smith has conceded to the realist criticism more than is strictly compatible with an idealist view: but at all events a highly interesting and even exciting sequel is promised.

The tendency exhibited in Prof. Kemp Smith's book to "democratise" the mind, as Prof. Alexander calls it, to put the mind in its proper place in relation to the rest of the natural order, has been operative in other regions than those of epistemology and metaphysics. The modern analytic movement in psychology associated with the name of Freud has been working to the same end. Its purpose is to interpret mind by its own natural history, and to show its dependence upon energies and functions which, if not simply bodily, are at least closely connected with the body.

The main tenet of the recent teaching on this topic centres on the larger meaning and greater significance attached to the conception of the unconscious. Dr. Northridge in his book (2) rightly singles out as the cardinal point in Freud's theory the distinction between the "preconscious" and the "unconscious." The older view of the unconscious regarded it as covering only those states of mind which were temporarily out of the field of consciousness, but could be revived, sometimes not without difficulty, but without special artificial preparation. This Freud designates the preconscious, reserving the name unconscious for those states which, because of their incompatibility with conscious interests, can enter consciousness only in a disguised and symbolical form, but which, though thus largely excluded or repressed, profoundly affect the tenor and quality of conscious life. Dr. Northridge explains the genesis of this conception through a discussion of Hartmann, Schopenhauer, Myers's theory (or theories) of the subliminal self, and those more recent students of the phenomena of dissociation and multiple personality like Janet, Sidis and Morton Prince. Chiefly, of course, he is concerned with Freud, and with the evidence on which Freud bases his revolutionary theory. With Freud's work, Dr. Northridge compares that of Jung and the late Dr. Rivers; and indicates the points on which he regards their later and broader treatment as more satisfactory. Dr. Northridge's book is almost wholly expository; he clearly takes Freud's work to be decisive on the general question as to the validity and fruitfulness of the analytical method. But within the limits which he sets himself it is a careful, competent and discriminating survey of the field, with its emphasis and contrasts well taken and justly marked.

On Freud's view, one of the main supports for the hypothesis of the unconscious is furnished by the study of wit. Mr. Gregory's learned discourse on laughter (3), however, is not unduly oppressed by Freudian theory. Freud, like Bergson, he believes to have thrown light on certain forms of laughter; but neither theory is universally applicable. Mr. Gregory works on a larger canvas. He ranges the whole field of recorded human laughter, from Homer to Charles Chaplin; and though the central idea which he derives from his survey is not novel, he illumines it with many fresh and suggestive analyses. His method is cautiously empirical. Laughter is endlessly varied in its occasions, forms and associated emotions. Still, if we follow the clue given by the physical process of laughter, it is possible to recognise in all forms of it one fundamental mechanical pattern, which may be described by the word "relief." Laughter occurs whenever an agent having prepared himself for action of some kind finds that action is unnecessary; it is the bodily concomitant of release from some position of tension. The variety of the forms of laughter is traceable to the very different ways in which this experience of relief can occur, from simple physical sensations like tickling to the most complex psychical situations. But certain main types of laughter can be distinguished; and, Mr. Gregory holds, it is possible to show how these types emerge and change with the progress of civilisation. The first type is ungracious laughter, laughter touched with contempt or animus, as against physical deformity or over a beaten enemy. But its later forms are more refined and kindly—as in the genial laughter of sympathy which is the source of humour, or in that distinctively intellectual form of it which is expressed in the comic spirit.

Mr. Marshall's treatise on æsthetics (4) takes the reader into a wholly different atmosphere. It is, in its way, an old-fashioned book, not over much concerned (except for Croce) with the most modern theories, but building a lucid and persuasive if not wholly convincing argument with a delicate and careful craftsmanship that is worthy of its theme. Mr. Marshall seeks first to develop his theory and definition of the beautiful. The conditions of beauty, he holds, cannot be stated in purely objective terms. An object, of course, is necessary, to provide the external stimulus; but since very different æsthetic judgments are passed on the same objective factors, there is clearly involved a subjective element as well. Where then is beauty to be found? —in sensation, or in perception or in the intellectual apprehension of certain formal relations subsisting between the parts of a perceived object? Or is its source rather in imagination or in emotion or in feeling, or perhaps even in religious and moral ideas? Each of these views, Mr. Marshall holds, might suffice to define some of our experiences of beauty, but none of them applies to all. Mr. Marshall's own account is that beauty is "relatively stable or real pleasure." "We call an object beautiful which seems always to yield pleasure in impression or contemplative revival." Similarly, ugliness is relatively stable disagreeableness.

One may perhaps suspect that if preceding theories have erred by defect, Mr. Marshall's zeal for an all-inclusive account leads him to err by excess. No doubt all experiences of beauty yield pleasure of the kind here described. But it does not appear that, as the theory requires, this proposition is convertible simply. There seem to be fields of relatively stable pleasures to which the term beauty cannot be strictly applied. The enjoyment of a strenuous game may be more stable, both in act and in recollection, than that of the loveliness of a fleeting sunset; but it is not therefore more beautiful, or even beautiful at all. Mr. Marshall is not unmindful of this difficulty. But his escape from it, mainly by an appeal to the revivals of meaning associated with particular pleasure experiences, scarcely goes to the heart of the matter.

The remainder of the book gives the application of the theory to some of the major questions of æsthetic philosophy; and a short historical review of the relation of various æsthetic theories to the metaphysical systems in connexion with which they have been developed.

"The Philosophy of Music" (5) is the sixth edition of a well-known book by Dr. William Pole. It is introduced and supplemented by short essays from Mr. E. J. Dent and Dr. Hamilton Hartridge. The book gives no hint to this later generation of the rather unusual combination of interests in its author, though the reader might guess from the treatment that Pole was much concerned with physics and structures. If further issues are called for, a biographical note would not be out of place. H. J. W. HETHERINGTON.

The Energetics of the Living Cell.

Chemical Dynamics of Life Phænomena. By Prof. Otto Meyerhof. (Monographs on Experimental Biology.) Pp. 110. (Philadelphia and London: J. B. Lippincott Co., 1924.) 12*s.* 6*d.* net.

THE scope of this fascinating addition to the series of American Monographs on Experimental Biology is restricted to the two fundamental and interconnected problems of cell respiration and the energetics of cell processes. The book is founded upon a series of lectures delivered in Cambridge and New York in 1922–23 and presents a connected account of the author's well-known work, considered in close connexion with that of other investigators, both in Germany and elsewhere.

These researches have revealed another example of the extraordinary complexity of the physical and chemical mechanism which has been evolved for the realisation of a fundamental physiological requirement, in this case the provision by the organism of energy available for the performance of work, either chemical or mechanical. Two methods for the accomplishment of this are found to exist, both subject, as are all processes in the living organism, to the limiting condition of a low and often an almost constant temperature. These are the aerobic system, in which the energy is derived from the oxidation of food materials, and the anaerobic, in which it comes from their fermentation. The comparative study of these two processes—respiration and fermentation—forms the subject of one of the most interesting chapters of the book, to which the previous sections on the mechanism of cell respiration and autoxidations in the cell serve as an introduction.

The author traces in detail the intimate relations which have been established between these two apparently independent but in reality closely allied processes, and concludes on a justifiably triumphant note: "It may indeed be considered a success of general physiology and its mode of experimenting, that the chemical dynamics of a highly differentiated organ like the muscle could be partly revealed by the study of the alcoholic fermentation of yeast."

The ensuing chapter, on the transformation of energy in muscle, carries the tale a stage further, and shows how far the tangled skein of physical and chemical changes involved in the contraction and relaxation of muscle has been unravelled. To appreciate the boldness of idea and skill in technique which have gone to the solution of this problem, this work must be studied in detail. To summarise very briefly and imperfectly, it may be said that during the contraction of a muscle, glycogen is rapidly converted into lactic acid, energy being thus rendered available by the chemical change and by the reaction of the resulting lactic acid with the alkali protein of the cell, too great a change of hydrogen ion concentration being at the same time avoided. So far the change is anaerobic and independent of the presence of oxygen. Relaxation is accompanied by the absorption of oxygen and the complete oxidation of a varying fraction, a quarter to a sixth, of the lactic acid, the remainder of the lactic acid being at the same time reconstituted into glycogen and the alkali protein of the cell restored to its original condition. Truly a remarkable device.

The concluding chapter is more general and speculative in its character, and deals with the difficult question of the constant exchange of energy which goes on in cells which perform no external work. No complete answer to this question has been obtained, but its investigation, particularly with respect to the metabolism of bacteria and algæ, has led to many important results which are here chronicled. One interesting point alone can be picked out for reference. The author has shown by direct experiment—poisoning a mass of respiring avian blood corpuscles in a calorimeter—that the old idea that living protoplasm has a higher energy content than dead is incorrect. No evolution of energy occurs at the moment of death, and the mysterious difference between living and dead matter cannot be explained on energetic grounds.

This short work must be regarded as a true romance of science, and to the sufficiently prepared reader its pages present a theme of the most enthralling interest. A pleasant feature of the book is the ungrudging recognition of the contributions of other workers to a subject which has aroused widespread interest and has been approached from many different directions.

ARTHUR HARDEN.

Our Bookshelf.

The Nature of Life. By Prof. W. J. V. Osterhout. (Brown University: The Colver Lectures, 1922.) Pp. vii+117. (New York: Henry Holt and Co., 1924.) 1.50 dollars.

A MOST pleasantly written book that discusses such questions as the origin, criteria and control of life in a manner making the story of what the biologist has done and is doing in that particular field readily intelligible to the educated lay reader. The United States is to be envied in having endowments permitting public lectures of this quality to be published in book form.

The question of the origin of life is discussed and, as is inevitable just yet, is not answered. This is followed by a discussion as to the criteria by which the living is to be distinguished from the dead. Growth is not a criterion, for there can be life without growth and growth without life. There can be life without reproduction; in individual cells, such as nerve cells, or organisms, such as the resting seed, there is no reproduction, no suggestion of cell-division, yet life may go on for many years. Motion is not one of the essential characteristics of living matter. There is no logical necessity for regarding the simplest cases of irritability as essentially different from certain reactions found in non-living systems. Constructive metabolism may cease, yet life may go on for many years; but the cessation of destructive metabolism marks the end of life. In the case of the resting seed, so long as it is alive it produces carbon-dioxide: when this ceases it is dead. Life as manifested in the simplest organisms is a physico-chemical process in which destructive metabolism plays a fundamental rôle. As soon as a cell dies its power of selective absorption ceases. Certain dyes will not enter a living cell; others will do so and become stored within, reaching a higher concentration than outside. The process obeys a definite mathematical law. This storage does not occur in dead cells to so great an extent. Another method is to send an electric current through the cell; by measuring the amount of the current the progress of death can be followed with the same exactitude as that of a chemical reaction. Death is an orderly process following a definite law that can be expressed mathematically. In order to control life it is first necessary to control mutation, and before this can be done the physico-chemical factors on which mutant characters are based must be completely analysed. With the control of mutation will come the power to create new species.

The Internal Secretions: for the use of Students and Physicians. By Prof. Dr. Arthur Weil. Authorised translation of the third German edition by Dr. Jacob Gutman. Pp. xviii+287. (London: G. Allen and Unwin, Ltd., 1924.) 18s. net.

THE author's method of presentation of his subject is one much to be recommended. Instead of dealing with each endocrine organ separately, he has chosen as subjects all the main physiological functions and describes the way in which each function is controlled by the endocrine glands operating either singly or in co-ordination.

Medical students and practitioners, for whom the book is intended, will certainly find in it much of interest and of value. Internal secretion is defined, the embryology and histology of the endocrine glands discussed, and there follow chapters on the physiology of the blood, circulation, respiration, metabolism, growth, reproduction, the sexual impulse, the mind, the chemistry of the endocrines; methods of testing for internal secretions; the inter-relationship of the endocrine glands; internal secretion and the nervous system. There is no bibliography, but the reader is referred to works of Biedl, Lipschütz, and others.

We agree with the translator that this book will be useful to students and general practitioners, and that medical specialists in other subjects will find in it sections dealing with the relation of endocrinology and their own special branches. This comprehensive elementary treatment is well suited to beginners, notwithstanding the fact that it contains within a small compass an immense amount of information. The book was not written for the endocrinologist, but by an endocrinologist for the German medical profession, and that which may be incomplete for the specialist may be more than enough for the general practitioner.

An Introduction to the Study of Southwestern Archæology: with a Preliminary Account of the Excavations at Pecos. By A. V. Kidder. (Published for the Department of Archæology, Phillips Academy, Andover, Massachusetts.) Pp. vii+151+50 plates. (New Haven: Yale University Press; London: Oxford University Press, 1924.) 20s. net.

FOR some years past American archæologists have devoted great attention to the south-western States, particularly New Mexico, and at the present moment excavations are being carried out on several sites. Of these Pecos in San Miguel County, New Mexico, is one of the most important, not only on account of its size, but also because of the length of time over which it was occupied by the Indian. There is a recorded occupation of practically three centuries, from 1540 until 1838, when it was abandoned, while the abundance of pottery of archaic type scattered among the mounds shows that it had been occupied for a long period before the coming of the Spaniards in the former year.

Although the account given in the second section of this volume is only a preliminary report dealing with the work in 1915 and 1916 and from 1920 onward, and it will be many years before the work is complete, it is already abundantly clear that the site is one of great importance and will without doubt throw much light upon the history and relative chronology of the development of culture in the south-western area. In the remaining three sections of the book, Mr. Kidder deals respectively with the history of Pecos, the results obtained from excavation of the other sites of the south-west which have been explored, and in conclusion summarises these results in a general sketch of the rise and development of south-western culture. As a whole the book is a valuable contribution to the study of American archæology which will prove of great assistance to those who wish to understand the general trend of current research in this part of the States.

Handbook to the Technical and Art Schools and Colleges of the United Kingdom. Compiled from Official Information. With an Index to Courses of Instruction. Second edition, revised and enlarged. Pp. iv+170. (London: Scott, Greenwood and Son, 1925.) 6s. net.

As a reference book to the technical schools and colleges of the British Isles, the volume before us will no doubt serve a useful purpose. It is divided into five sections, dealing respectively with London, England (provinces), Scotland, Wales, and Ireland, the last section being subdivided into two sections covering Northern Ireland and the Irish Free State. In the London group the schools are arranged alphabetically, whereas in the remaining sections they are under towns, which again appear in alphabetical order. Under each entry is given essential information about the school, together with an indication of the courses of study, day and evening, which are available. There is a full index to the courses of instruction, so that it is possible to see quickly where any particular subject is studied.

Stories of the Birds from Myth and Fable. By M. C. Carey. Pp. 192+8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 5s. net.

THE author of this book has culled from many standard works on the folklore of peoples such myths, legends and fairy tales as relate to birds, and has recast them in simple language suitable for children. The result is a series of quite charming tales, delightfully told, which, in the pleasant guise of fable, include a considerable measure of true and salient facts about the form, habits and natural history of birds. Primitive man was always a close observer of natural things, and the myths which centre round natural phenomena are merely his attempts to find reasons for things which he could not otherwise explain.

Children will be delighted with this book. Those who are students of birds will be no less interested in the ingenious and fanciful explanation of avian habits and structure put forward by early man.

Skill in Work and Play. By Prof. T. H. Pear. Pp. 107. (London: Methuen and Co., Ltd., 1924.) 4s. net.

THIS book is a study of the way in which muscular skill is acquired. It is eminently popular in exposition; but behind its somewhat racy style lies the weight of facts that have been investigated in carefully planned research. Prof. Pear applies the facts, originally brought to light in connexion with problems of industrial psychology, not only to the acquisition of dexterity in such operations as typewriting and metal polishing, but also to those of athletic skill as exemplified in cricket, skating, and similar games and sports.

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 Taungs Skull.

I OWE to the kindness of my friend Dr. Broom a preliminary sketch of a sagittal section through this remarkable skull. Prof. Dart, though he is himself earnestly engaged in the description of the skull, has generously afforded Dr. Broom full access to it with permission to publish any observations he may make.

As the preliminary section is extremely interesting and completely confirms, so far as it goes, the statements of Prof. Dart, I have been tempted to compare it with similar sections through the skulls of young chimpanzees preserved in our University Museum, which my friend Prof. Goodrich has kindly put at my disposition.

In Fig. 1 the profile of the Taungs skull (continuous

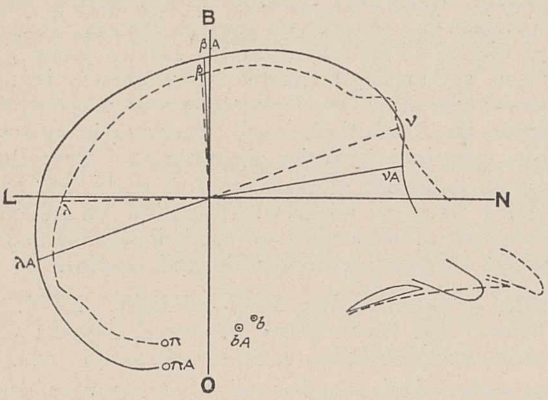

FIG. 1.—Superposed profiles of Taungs skull (continuous lines) and of skull of young chimpanzee, one true molar erupted (broken lines). *OB.*, occipito-bregmatic axis; *LN.*, lambda-nasion axis; ν, nasion; β, bregma; λ, lambda. Points on the Australopithecus profile are distinguished by the addition of the letter *A*. (× about ½; the greatest length of the Taungs skull is 127 mm.)

lines) and that of a young chimpanzee (broken lines) are superposed on a common morphological centre and the bregma-occipital axis. The greater size of the Taungs skull is sufficiently obvious, and equally so the complete absence of a frontal torus, while this feature is already well developed in the chimpanzee. The bregmas are nearly coincident but the lambdas are far apart, and the parietal arc of the Taungs skull (108°) is therefore considerably larger (19°) than that of the chimpanzee (89°). This marks an approach towards the human side. The comparative shortness of the face and the diminished prognathism of the Taungs skull are also well displayed.

I ought to mention that the basion and opisthion are not preserved in the Taungs skull, but their probable position has been indicated by Dr. Broom with a possible error of 2 mm. for the opisthion and 4 mm. for the basion.

In Fig. 2 the profile of the Taungs skull is compared with that of a chimpanzee already furnished with a complete dentition. It will be seen that the Taungs skull, although in an earlier stage of development, has attained to a profile of about the same area as that of the adult chimpanzee, which in this specimen has a cranial capacity of 440 c.c.

In Fig. 3 full sagittal sections are given in place of profiles, and that of the chimpanzee has not been obtained from the one shown in Fig. 2 but from another adult specimen. No stress can be laid on the comparison of the two sections, since they represent different stages of growth. In a young chim-

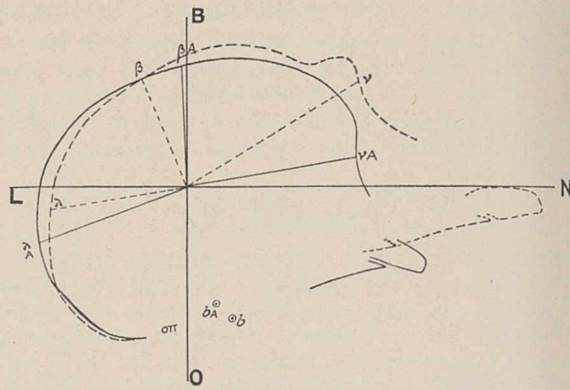

FIG. 2.—Profiles of adult chimpanzee and Taungs skulls superposed. (× about ½.)

panzee, with only the first molar erupted, the anterior extremity of the brain may extend much farther downwards than in the adult.

Attention, however, may be directed to a peculiarly interesting feature of the Taungs skull as displayed in this figure. It will be seen that the nasion is situated, as in man, close to the anterior limit of the brain. In the higher apes this relation is lost at an early stage; the nasion rises progressively with age, and so does the frontal bone, which seems to turn upon the bregma as upon a hinge. This is well illustrated by the profiles of chimpanzees in different stages of growth shown in Fig. 4.

I should have liked to make a comparison with the skulls of young gorillas, but unfortunately our collection does not contain any skulls in which the first true molar has alone been cut. We have adult skulls and some with the deciduous dentition only. Of the latter there is, however, one in which the first molar, though still occluded, is not far from eruption,

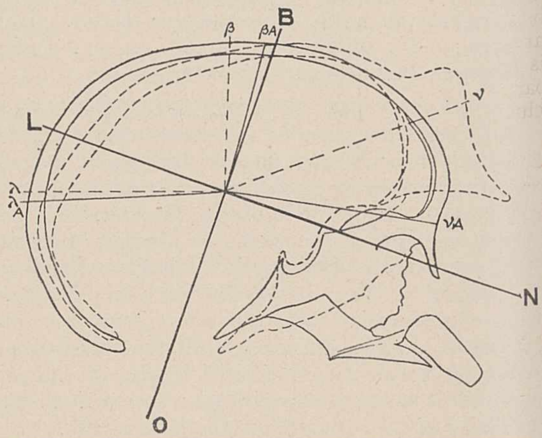

FIG. 3.—Sagittal sections of Taungs skull and skull of adult chimpanzee superposed. (× about ½.)

and this skull closely resembles in profile that of the chimpanzee of Fig. 1. The areas of the profiles are almost identical, and the frontal torus of the gorilla is only faintly expressed.

There is nothing in these observations which would lead one to conclude that the adult Australopithecus possessed a much larger brain than any existing ape. The gorilla, as shown by Selenka, has a brain of 400 c.c. in the young stage, when it possesses only the deciduous dentition, and it attains to a maximum of 590 c.c. in the adult. This, however, is a matter of only secondary importance. It is abundantly clear

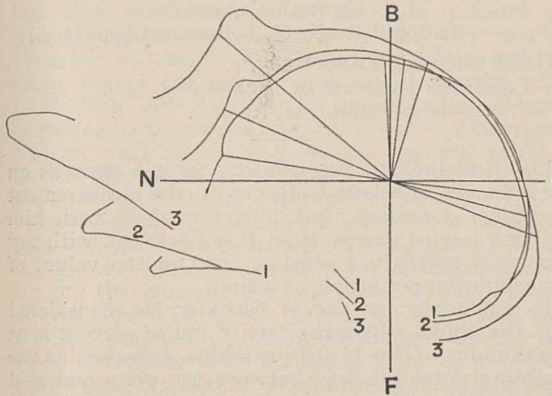

FIG. 4.—Profiles of the chimpanzee skull in different stages of growth.

that in a number of significant morphological characters, such as complete absence of the frontal torus, position of the nasion, greater magnitude of the parietal arc, reduced prognathism and shortening of the maxillary region, Australopithecus makes a nearer approach to the Hominidæ than any existing anthropoid ape. W. J. SOLLAS.

University College, Oxford.

The Discovery of Benzene.

IN view of the projected celebration of the centenary of Faraday's discovery of benzene in 1825, it is important that any doubt concerning his priority should be dispelled. The standard work on coal-tar, Lunge's "Coal Tar and Ammonia," states on p. 223, vol. 1 of the fifth edition (1916): "It is usually stated that benzene was discovered in 1825, by Faraday, in the liquid separating from condensed oil-gas, but Schelenz (*Z. angew. Chem.*, 1908, p. 2577) has shown that the compound which we now term 'benzol,' or more recently 'benzene,' had been discovered in coal-tar forty years before Faraday in the year 1825 reported 'On new compounds of carbon and hydrogen. . . .'" Lunge then quotes from Schelenz three passages, culled from the chemical literature of the period 1740–1784, which in the opinion of both prove that benzene "was undoubtedly known forty years earlier" (although elsewhere in his article Schelenz refers to "Faraday's discovery, of which England can indeed be proud"). The citations from the eighteenth century are from German versions of Macquer's "Dictionary of Chemistry" (Leipzig, 1783), Demady's "Laborant" (Leipzig, 1784), and Caspar Neumann's "Prælectiones Chemicæ" (Schneeberg, 1740).

These works not being available, reference was made to similar English versions. In volume 1 of the English translation of the first French edition of Macquer's work (1766) we read (p. 166, footnote): "Fossil coal by distillation yields 1. a phlegm or water; 2. a very acid liquor; 3. a thin oil like naphtha; 4. a thicker oil, resembling petroleum, which falls to the bottom of the former, and which rises with a violent fire; 5. an acid concrete salt; 6. an inflammable earth remains in the retort." In volume 1 (p. 385) of "The Chemical Works of Caspar Neumann, M.D.," edited by William Lewis (second edition, London, 1773), the author states that 48 ounces of the best sort of pit-coal from Halle heated in a glass retort with a fire gradually increased, yielded 2 ounces 7 drachms of phlegm: 2 ounces and 1 drachm of a thin fluid oil, and 1 ounce of a thick, tenacious, ponderous, pitchy oil, which stuck in the neck of the retort: the residuum weighed 40 ounces 7 drachms. . . . That which distilled at first was light, and swam on water; the succeeding parcels proved more and more gross and ponderous, and at last sunk." The coarse stony pit-coal of Halle yielded no oil.

These quotations will suffice to show that the chemists of that period knew how to obtain by destructive distillation of certain coals a number of loosely-defined *mixtures* as fractional distillates, but they afford no evidence whatever that the light-oil or any other fraction was known to contain a definite, homogeneous chemical individual, which we know as benzene. Nevertheless, Schelenz states that Neumann certainly had benzene before him! Undoubtedly he had, but only as one constituent of a very impure mixture; and the preparation of a mixture which years later is proved to contain a hitherto unknown chemical compound does not constitute a discovery of that compound. Has Liebig ever been credited with the discovery of bromine? He actually saw it years before Balard "discovered" it. It is surprising that the statement in "Lunge" should have remained so long unchallenged; and it is fitting that at this time it should be given an unqualified and definitive denial.

It might be contended that Faraday's title to the honour of discovering benzene is rendered doubtful by the fact that he did not obtain it in a pure state. In his paper to the Royal Society (Phil. Trans., 1825, p. 440) Faraday admitted that his "bicarburet of hydrogen" was impure ($C = 11 \cdot 576$, $H = 1$, compared with $C = 12$, $H = 1$, required by theory), probably because it contained another hydrocarbon containing 8·25 parts of carbon to 1 of hydrogen. In this connexion it is interesting to compare Faraday's values of some of the physical constants of benzene with the values accepted to-day (Faraday's values are given first): sp. grav. 0·85 (at 15·5° C.): 0·8850 (at 15° C.); melting point 5·5° C.: 5·483° C.; boiling-point 85·5° C.: 80·2° C.; density of vapour ($H = 1$) nearly 40 : 39. Allowing for different degrees of accuracy of the measuring instruments in use a hundred years ago and of those now available, the conclusion seems to be justified that, without any doubt, Faraday was the first to isolate benzene in a substantially pure state; and there has never been any question that he was the first to investigate its physical and chemical properties. E. H. TRIPP.

May 27.

Double Impacts by Electrons in Helium.

IN a paper on the precise measurement of the critical potentials of gases (Proc. Roy. Soc., 107-291, 1925) Mr. E. G. Dymond finds that the difference between the first and second kink in the current potential curve in helium is 20·9 volts and not 20·55 volts as one would expect if the first kink corresponds to electrons which have caused the transition $1S - 2s$ (type A), and the second kink to electrons which have caused two transitions $1S - 2S$ *and* $1S - 2s$ (type BA). In attempting an explanation he assumes that in his apparatus the second kink is due to the transition BB.

I would like to suggest in the first place that this disagreement is possibly explained when the energy lost by *elastic impacts* between electrons and helium atoms is taken into consideration, and in the second place that the double impacts are probably of the type BA or AA, rather than of the type BB assumed by Dymond.

Taking up the latter point first, if it is assumed that at forty volts the probability of a B transition is greater than of an A transition, then I believe that the second kink is of the type BA and not of the type BB for the following reason. As the accelerating field is gradually increased in the neighbourhood of forty volts, the electrons *first* get enough energy to cause the double impact of the type B followed by type A, *before* they get enough energy to cause the double impact of type B followed by type BB. The double impact is then of the type BA. However, if it is assumed that at forty volts the probability of type A transition is greater than for type B, then the double kink will correspond to type AA. That is, the second impact of the first double kink will always be of type A. Of course as the field is further increased the type BB would, in the ideal case, appear as a second double kink 0·8 volt higher than the double kink of type BA. In this ideal case (no energy losses by elastic impacts and maximum probability of impact at the critical potential), the difference between the double kink and the single one would for type AA be 19·77 volts, for type BA 20·55 volts, and for type BB 21·33 volts, as has been assumed heretofore.

If, however, the energy losses due to *elastic impacts* are taken into account, then I arrive at the following relations for the energy spent by typical electrons which start out with the energies found by Dymond as corresponding to the first and second kinks.

For a single impact of type A:

$$22{\cdot}2 + C = E'_A + 19{\cdot}77 + R_A \quad . \quad . \quad (1)$$

For a double impact of type BA:

$$43{\cdot}1 + C = E_B + 20{\cdot}55 + E_A + 19{\cdot}77 + R_A \quad . \quad (2)$$

The left-hand side of both equations represents the *total* energy of the electrons, 22·2 volts and 43·1 volts being the points on Dymond's curves where the drop in current is most pronounced. The quantity C is the correction due to initial velocity. E'_A is the energy lost by elastic impacts which precede the inelastic one which a 22·2 volt electron makes. Similarly E_B is the average energy lost in elastic impacts by a 43·1 volt electron before it makes inelastic impact of type B, and E_A is the average energy lost by elastic collisions of the same electron *after* it has made its first inelastic impact (type B), and before it made its second inelastic impact (type A). In both cases $(19{\cdot}77 + R_A)$ is the potential at which the probability of type A transition is a maximum.

Subtracting equation one from two it is found that

$$20{\cdot}9 = 20{\cdot}55 + E_B + E_A - E'_A \quad . \quad . \quad (3)$$

It is seen that the difference between the kinks is not equal to the critical potential, but that it differs from it by the quantity

$$(E_B + E_A) - E'_A = 0{\cdot}35 \text{ volt.}$$

A figure so large as 0·35 volt for the difference in the energy lost by elastic impacts in the two experiments does not seem unreasonable. It can be shown from the laws of the conservation of energy and momentum that a forty-volt electron loses 0·010 volts per impact with a helium atom, while a twenty-volt electron loses only 0·005 volt per impact. Hence, since Dymond estimates that an electron makes in the neighbourhood of a total of 400 collisions in passing through his apparatus, one need not be surprised by a difference of the order of 0·35 volt in the amounts lost by elastic impacts in the two different experiments.

If the above views are correct, it means that for a gas of small atomic weight like helium the usual method of correcting for initial velocity and contact potential, by taking the difference between kinks equal to a critical potential of the gas, is not permissible.

I am indebted to Prof. R. C. Tolman of this institute for the opportunity of discussing these matters with him.

GEORGE GLOCKLER.
(National Research Fellow in Chemistry.)

Gates Chemical Laboratory,
California Institute of Technology,
Pasadena, California, April 9.

I AM indebted to Mr. Glockler for his remarks on the influence of elastic collisions on the measurement of critical potentials, but I cannot agree with him that the loss of energy from this cause can with my apparatus result in a sensible error in the values of the excitation potentials of helium.

In analysing my curves Glockler has considered only the points where the rate of fall of current is at a maximum. This is not justifiable, however, as the retarding potential used between the plate and grid was 0·5 volt. This implies that the current drop at any point does not represent the number of inelastic impacts at that potential, but the number integrated backwards over a range of 0·5 volt.

If, however, we deal, as in my measurements I have done, with only the first break points, a little consideration will show that energy loss by elastic impacts can play no rôle but that of reducing the region in which an electron can effectively collide; that is to say, that it can only reduce the probability of inelastic collision, as at the critical velocity any energy loss renders the electron incapable of exciting. This means that inelastic impacts first take place in the neighbourhood of the grid and gradually spread throughout the apparatus as the voltage is raised. The reasoning, of course, applies alike to the single and double impacts.

This independence of the position of the kinks on the loss of energy by elastic impacts is a property of the type of apparatus used. Benade and Compton (*Phys. Review*, 11, p. 284, 1918) have, of course, shown that when a number of collisions can take place during acceleration of the electrons, the position of the kinks is a function of the pressure, but in the apparatus used by me the electrons are accelerated to their full velocity before making any collisions.

The reduction in the probability of effective collision for voltages immediately in the neighbourhood of the critical potential will certainly make the kinks less sharply marked, but I think that an inspection of my differential curves will show that an error of 0·1 volt is the most which can be made from this cause.

E. G. DYMOND.

Zweites Physikalisches Institut der Universität,
Göttingen, Germany, May 8.

Possible Effects on Marine Organisms of Oil Discharged at Sea.

THERE have recently appeared in the Press imaginary descriptions of devastations caused among larval fishes and other marine organisms by oil floating on the sea. So far as the present writer knows, these descriptions—some by influential writers—are anticipations of what might occur if oil were a moderately poisonous substance. Oil is certainly noxious, and the writer is fully in agreement with the descriptions which have been given in the Press of the disgusting conditions due to it at high-water mark along our shores and sometimes also at sea, but there is little evidence as yet to show that the kind of oil lost or discharged at sea is even mildly poisonous. For this reason it is necessary to adopt a much more agnostic view than is at present current with regard to the effect of oil on marine organisms. The kind of oil used for fuel on ships at sea is, I am informed, entirely petroleum oil in its crude state or the residue left after the separation of its more valuable and lighter constituents; but it is unlikely that much of these oils will escape or be knowingly discharged from ships, except the heavier residues along with waste lubricating oil. Until it is known what chemical constituents this waste oil contains, it is premature to imagine that it has any serious harmful effect on marine organisms. The more poisonous coal-tar oils are apparently not used as marine fuel oils.

Experiments by Orton and Elmhirst on petroleum residues, taken from masses of this material floating on the sea, indicate—as do some chemical analyses by the Government Chemist—(see Orton, Fisheries Investigations II, 6, No. 3, pp. 134–145)—that these oils are practically non-lethal, either directly from toxic constituents, or indirectly from their physical properties. Indeed, it is doubtful if these substances are as poisonous as human urine. These samples of oil, however, are only two of a large number which require to be tested before previous contact with sea water.

The effect of a lubricating oil on marine organisms was observed by the present writer on a wreck, ss. *Rock Highland Bridge*, which sank off Falmouth Harbour and was moved inshore to the mouth of the Helford River. This wreck had not been an oil-burning vessel, but oil was escaping in small globules from the engine-room and had covered the starboard side of the vessel amidship with a coat of congealed oil for about ten yards. This oil was smeared over a quantity of young mussels and limpets (Patella), which were found to be clean and healthy and approaching sexual maturity. A number of fishes—pollack, gobies and smelts—were swimming close to the rising oil and below the oil film, and also close to the oily side of the vessel was found a shoal of copepods, mainly *Calanus finmarchicus*, which is notoriously an inhabitant and apparently a lover of good clean water. The mussels mentioned above were stunted in growth, it is true, but dwarfing in situations near high-water mark—as these were—is well known (see Orton, Jour. Marine Biol. Assoc., vol. 10, 1914, p. 319). Thus from actual experiments and observations on certain oils there is ground for taking the view that—apart from actual contact with oil, and not always even then—oils such as are lost at sea are not very dangerous to marine life.

It is an obvious and deplorable fact that birds which become fouled with oil have died and are still dying off in consequence in considerable numbers, but there is little ground for statements that any organisms on the shore are being killed off in wholesale fashion. It is indeed rare to find objects smeared with oil on the shore anywhere below about high-water neaps. A thick oil may become entangled in a branching wet surface, such as some seaweeds offer, but not easily.

Even water-gas tar, which is known to contain poisonous constituents, was found by Mitchell (Bull. U.S. Bureau of Fisheries, 32, p. 199, 1912) to be harmless to oysters in running water, though the tar had previously been *injected* into the mantle-cavity of the bivalve. The explanation of this is probably simply that the tar was immediately or soon shot out of the precincts of the shell and was unable to adhere in any significant amount to any of the soft parts, which are normally wet and covered with a film of mucus which is easily sloughed.

If one supposed that oil contained a fair amount of soluble poisonous substances, the fact that oil forms a film on the surface of the water would cause the toxic substance to be exposed to immediate dilution which would soon become great in any tideway. If, on the other hand, fish eggs, for example plaice eggs, were floating near the surface under a layer of oil in a rubbly sea, it seems possible that globules of oil may come in contact with the eggs or larvæ, but if they did, would they envelop them and kill them? If potential fishes were killed in this way, what area of the ocean would be affected by the oil and to what depth in these areas would the oil affect living organisms? All these questions are relevant, and no doubt answers to some of them could be obtained by simple laboratory experiments.

One further fact of interest was observed in my own experiment with a petroleum residue taken from the sea. After about six weeks contact with sea-water, the oil hardened into a scum and began to sink, but before it sank crowds of a small white polychæte (Ophryotrocha) were found eating the scum of oil—probably for the sake of the bacteria feeding on the oil in turn. Ophryotrocha is a notorious scavenger, and is frequently taken in thousands from an old boot dredged up from the sea. Some oils, therefore, add to the available food-material in the sea, and it is clear that further information is required before we can actually gauge the effect of oil upon the sea on the life below the surface.

J. H. ORTON.

The Laboratory, The Hoe,
Plymouth, May 19.

Salps and the Herring Fishery.

RECENTLY the chairman and one of the scientific staff of the Fishery Board for Scotland, after two seasons (1920 and 1921) in which the shoals of herring had been scarce in their usual haunts, published communications in which it was suggested, though not distinctly asserted, that certain Atlantic currents had filled the usual grounds with hordes of salps—to the detriment of the herring. By and by it was pointed out by those familiar with salps and their life-history that such a suggestion was untenable. Now, we have an article (*Scotsman*, May 5) in which Mr. Arthur Samuel, M.P., Minister for Overseas Trade, again revives the subject, and by using the term "jelly-fish" for the salps has not added to the simplicity of the matter; for salps are in no way connected with jelly-fishes in structure, mode of feeding, development, or life-history.

This confusion is seen in the letter Mr. Samuel gives from the American Fish Commissioner, who descants on the voracity of the jelly-fishes, so long ago humorously told by Edward Forbes, which leads them to engulf forms much higher in the animal scale than themselves, *e.g.* young fishes. So much is this the case that if the tow-nets and collecting vessels are not quickly attended to, the small jelly-fishes and ctenophores (Thaumantias and Pleurobrachia) levy a heavy toll on the young fishes.

But salps do not feed like jelly-fishes and their stomachs are ill-fitted for such a diet. The American author, indeed, suggests that the currents which conveyed the salps to these regions probably caused the migration of the herrings, though this is still in want of proof. He adds a word in favour of the jelly-fishes in so far as certain young fishes shelter under their discs, and he might have supplemented this by the fact that the Japanese dry and eat certain forms.

These facts, however, are altogether beside the question of the effects of hordes of salps on the herring fishery; and Mr. Samuel concludes that he is "not certain that salps were the direct cause of the ill effects of our herring fishery," though he goes on to say that salps may consume the minute organisms on which the herring feed, a statement also requiring proof. He supposes that the salps float on the surface of the water only—which they certainly do in fine, calm weather with a smooth sea, their contractions breaking the surface like tremors on molten glass. But the moment a storm of wind and rain sets in they disappear from the surface, and they may be beached in long lines six or more inches deep on the tidal margin like masses of boiled sago. In ordinary calm weather, again, one might look from a boat into the deep water of the Hebridean lochs and observe at all depths chains of salps and solitary individuals moving slowly therein as well as at the surface. Indeed, when the climax of the invasion was reached the sea in Lochmaddy for long distances resembled boiled sago, and with every stroke of the oars the salps rose from the water and rolled like glassy crystals from the blades. Further, swarms of gulls swooped down on the larger salps and picked out the nucleus (containing the stomach and the heart), leaving the victims to continue their slow, gliding motion as if nothing had happened. Moreover, many of the littoral animals greedily feed on the salps, even the little stony coral (Caryophyllia) having its soft tissues above the corallum distended to bursting with salps.

What the gulls and invertebrates delight in, surely fishes, and more especially herrings, do not despise, for, as first suspected by Dr. H. C. Williamson, long on the scientific staff of the Fishery Board for Scotland, and now on that of the Canadian fisheries, the herrings, less adept than the gulls in dissecting out the nucleus, swallow the salps—nucleus and all. Instead, therefore, of being a scourge, which swept the herrings from their wonted haunts, the salps would rather prove a welcome source of food.

W. C. McIntosh.

Vernier Wireless Time-signals.

The Colaba Observatory has had under regular observations the time-signals broadcasted from Eiffel Tower and Nauen. A good deal of confusion was sometimes caused when the Observatory clock, which showed almost perfect agreement with the ordinary signals (old system) transmitted from Eiffel Tower between 22 hr. 44 min. and 22 hr. 49 min. G.M.T., received here between 4 hrs. 14 min. and 4 hrs. 19 min. Indian Standard Time, showed a considerable difference, occasionally so much as 0·8 of a second, when compared about an hour later with the Nauen signals (international system), which end at Greenwich midnight. The rate of the clock is so small that during the interval of an hour the clock developed negligible error; the difference between the two stations was consequently considered unfortunate, although this difference was ordinarily small.

The question naturally arises what order of accuracy an observatory should attempt in its time determination. Both Eiffel Tower and Nauen transmit vernier time-signals which enable one to obtain very accurate comparisons, the probable error not exceeding 1/100 of a second, but if these two stations themselves differ by even 0·1 of a second, the accuracy attainable from the vernier signals becomes meaningless. As Eiffel Tower transmits the exact times of the first and the last of the series of 300 dots, and Nauen does not, and as Eiffel Tower time shows a better agreement with Bombay time, greater reliance has been placed by the Observatory on Eiffel Tower signals than on the Nauen. It would be interesting to know the experience of other institutions in this matter.

S. K. Banerji.

The Observatory,
Bombay, April 9.

The question raised by Mr. Banerji is certainly important from the point of view of exact astronomy, but it is not new. It was fully discussed several years ago, and at Rome in 1922 the geodesists stated that field operations with small instruments in the open did not show anything like the large range shown by the fixed transit circles of the leading observatories. It was conjectured that the confined air in the transit circle rooms might cause some *lateral refraction through irregular stratification*. At a recent meeting of the Royal Astronomical Society Prof. Sampson put the discordances down to abnormalities in the level determinations, but the Astronomer Royal found it difficult to accept this suggestion. It appears from Mr. Banerji's letter that he has missed the earlier discussion.

Part of the difference between the different national observatories arises from the use of different solar tables, and consequent difference in the reduction from sidereal to mean time. This amounts to as much as 0·06 sec.

There is the further point that the daily time-signals necessarily rest on *preliminary* values of the instrumental errors. There is not time to discuss these fully before sending out the signals. The error from this source may approach 0·10 sec.

Andrew C. D. Crommelin.

55 Ulundi Road,
Blackheath, London, S.E.3.

The Sound of Lightning.

Capt. C. J. P. Cave's letter in Nature of May 23 reminds me of a storm at Little Shelford in 1915. I had waited for it to stop before I cycled in to Cambridge, and I started when there was clear blue sky in the zenith. An unexpected flash struck from the rear edge of the cloud before I had reached the garden gate, and damaged a tree within a hundred yards of me, near the village post office. The thunder was almost immediate, but was definitely preceded by a noise which I said was like "a sudden rending of calico"; Mr. Cave's "swishing" noise would also describe it. I was working on sound-ranging at the time, and thought the cause of the noise was probably analogous to the explosion wave, travelling faster than sound, which disturbs sound-ranging calculations for the last few yards of a gun's position.

W. Lawrence Balls.

The Orchard House,
Bollington Cross,
Near Macclesfield,
May 29.

Hypothecate.

If a man prefers long words to short, who shall blame him? If he thinks Greek compounds more suited to the style of a learned paper, let us not hurt his dignity by carping. But we have a right to ask that he shall use such words correctly. Therefore it may be urged without offence that the many who like to write the word "hypothecate" when they mean "suppose" should first look that word up in the dictionary.

One who has done so.

The University of Bristol.

Opening of New Buildings.

On June 9 their Majesties the King and Queen opened the new wing of the University of Bristol before a distinguished gathering of representatives of the city and surrounding counties. The magnificent tower (Fig. 1) and the new buildings were the gift of Sir George Wills and his brother, the late Mr. H. H. Wills, in memory of their father Mr. H. O. Wills, the founder of the University. The scholarly genius of the architect, Mr. George Oatley, upon whom the King has just conferred the honour of knighthood, is revealed in every detail.

The building, with its imposing entrance hall, contains the main library of the Faculty of Arts and the extensive collection of medical works presented to the University by the Bristol Medical and Chirurgical Society. It also contains the whole of the administrative departments, the great hall of the University, with its hammered oak roof and carved oak panelling, the Senate and Council Room, as well as lecture rooms and private rooms for the whole of the members of the Faculty of Arts.

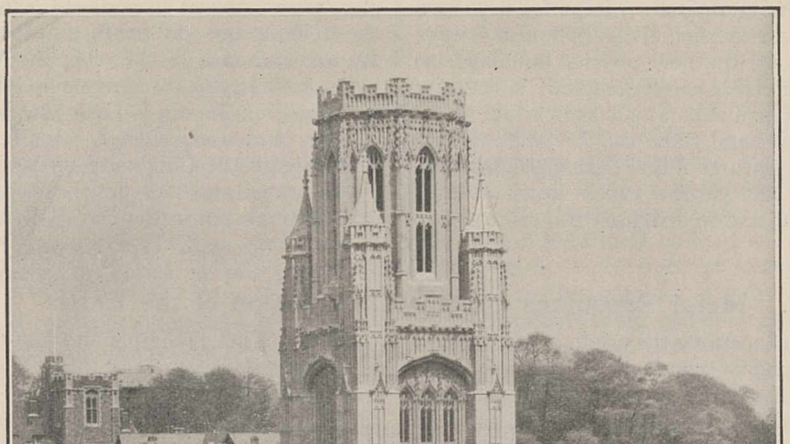

Photo.] [*F. Beech Williams.*

Fig. 1.—The University Tower, Bristol, from Berkeley Square.

The University of Bristol, like so many similar institutions, arose from a University College founded in 1876, which was affiliated and later completely fused with the Bristol Medical School, founded in 1832. The University received its Charter in 1909. The Society of Merchant Venturers, which joined with the city in the petition for this Charter, gave its well-equipped engineering laboratories, and has since maintained the entire Faculty of Engineering as its gift to the common good. There are few institutions in Great Britain which can show such rapid growth in the brief period of sixteen years, part of which was occupied by a devastating war.

No sketch such as this can possibly pay personal tribute to the many administrators who laid the foundation or to the academic staff who created the reputation on which they built. There would have been no University had it not been for such men as Percival, Dean Elliott, Jowett, Temple, Procter Baker, Lewis and Albert Fry, Arrowsmith, P. J. Worsley, and H. Napier Abbot on one hand; and Rowley, Marshall, Sollas, Silvanus Thompson, Lloyd Morgan, William Ramsay, Sydney Young, and Morris Travers on the other. It could not have come into being without the princely generosity of members of the Wills family, the financial assistance of the city of Bristol and the surrounding counties of Gloucester, Somerset, and Wilts, and the cities of Bath and Gloucester, all of which contribute from their rates.

The Science and Medical Faculties of the University are already housed in other buildings and further developments for various sciences are in progress. The recent removal of the Faculty of Arts to the wing now officially open sets free a number of rooms adjoining the departments of geology, botany, and zoology into which they are expanding. That such expansion was a most pressing need can be realised by the fact that the chemical department, erected in 1910 and regarded at the time as not only complete but also adequate for all possible contingencies for thirty years, is now seriously overcrowded owing to the important schools of research it is called upon to accommodate. Still further relief will be afforded when the physics department leaves its present inadequate quarters and takes up its permanent home in the magnificent H. H. Wills laboratory in the grounds of the Royal Fort estate.

Again, the University has to thank the late Mr. H. H. Wills both for the estate and buildings. The erection of the physical laboratories on this commanding site has been progressing slowly but steadily, and they will be ready for occupation in about eighteen months. In this case also it would appear that provision is being made for its full growth for at least a generation, but the history of the chemical department leads any such statement to be received with caution.

The Royal Fort estate is beautifully situated on one of the highest points in Bristol; except for a portion now being used as an extension of the Botanical Garden and that occupied by the new physics buildings, no other sites have yet been earmarked, but it contains space for other departments which are certain to be wanted in the future, and these can be built without destroying the main features of the charming eighteenth-century residence and garden which forms a large portion of the estate, and so delighted the visitors who attended the garden party held there on June 9 after the opening ceremony.

Another delightfully situated eighteenth-century residence, Clifton Hill House, was presented to the University in 1909 as a hostel for women students, and was extended in 1911 by the addition of the adjoining Callender House. At present the men are accommodated in Mortimer House and Canynge Hall, but in the near future a magnificent hostel is to be erected by Sir George Wills on the far side of the Downs on an estate presented to the University by Mr. H. H. Wills close to the athletic grounds at Coombe Dingle. Finally, the students and staff are fortunate in possessing a well-known landmark in the city, the Victoria Rooms, in close proximity to the University, where their Majesties had lunch on June 9. These fine buildings have been bought, endowed, entirely modified internally, and presented to the University for the purpose of a Club, by the same generous donor whose name will be for ever remembered in the city of Bristol.

Metal Resources and the Constitution of the Earth.

SPECULATION concerning the origin of ore deposits has been for many years, and is at the present time, dominated by the school of theorists who attribute a proximate and direct igneous origin not only to igneous segregations, contact deposits, and the metalliferous vein-deposits immediately associated with igneous intrusions, but to metalliferous veins generally. The grip attained by this theory is such that only rarely do authors of papers take a larger and more comprehensive view of either the possibilities or the actual facts of vein-formation. The extent to which the mind of the average worker is obsessed by the igneous theory is shown by the tendency to apply it in cases where it seems almost certainly inapplicable. In bedded iron-ores, sedimentary lead- and zinc-ores, and even petroleum, the igneous enthusiast sees clear evidence of metalliferous solutions and vapours rising through the earth's crust and effecting mineralisation at all levels on their way to the surface.

When igneous rocks are present anywhere within reasonable reach of metalliferous deposits, the igneous enthusiast is of course particularly happy. These igneous rocks may be miles away, but what does that matter? They may be entirely absent from the surface of a whole region; but that does not disturb his cheerful faith that somewhere the barysphere is bubbling. Indeed, at even shallower depths than the barysphere, are there not the seething metalliferous cauldrons of the magmasphere? The fact that both are well out of the way and far beyond the reach of observation comforts him rather than stirs his doubts, for on this account the barysphere and magmasphere are even more useful as a basis of speculation than they would be otherwise.

The notion that metalliferous veins have been deposited by solutions and vapours escaping from the barysphere was first made attractive by Posepny, and was freely adopted by students of ore genesis, partly on account of its simplicity and plausibility, and partly because it was regarded as the only alternative to the theory of lateral secretion, which had been found wanting. Though simple and plausible, however, it is almost certainly false, and the geological case against it was very fairly stated by Le Conte, in his contribution to the discussion on Posepny's paper. In recent years the igneous theory has gradually assumed a form in which it is more acceptable to geologists, the seat of the juvenile metals being fixed, not in the barysphere, but in ordinary rock-magmas originating at comparatively shallow depths. In this form the igneous theory is just as simple and plausible as it was in the barysphere form, and it is more difficult to refute, although, as applied to most deposits, it is probably nearly as false; but if so, whence came the metals of the vein deposits and contact deposits so often associated with igneous intrusions?

This problem, which is not only interesting in itself on purely scientific grounds, but is also important in its bearing on metal resources, was considered by Sir Thomas Holland in his presidential address at the annual general meeting of the Institution of Mining and Metallurgy on April 23. The ground he took was the contrast between the small percentages of the less abundant metals in the earth's crust as a whole, and their percentages in ore deposits. Taking the average composition of igneous rocks calculated by Clarke and Washington (see NATURE, Aug. 19, 1922, p. 254) as the best data available, he pointed out that, according to these data, elements formerly regarded as rare, such as zirconium and cerium, are more abundant in the earth's crust as a whole than are the familiar base metals copper, zinc, lead, and tin. Again, nickel, which is produced in comparatively small amounts, is ten times as abundant as lead and some hundred times as abundant as tin.

Adopting the now apparently well-established view that the earth has a large core of nickel-iron, which is surrounded by silicate-rock shells decreasing in basicity from an inner shell of peridotite to an outer one of granite-gneiss, Sir Thomas Holland states that the natural home of the heavier metals is deep down in the core, and asks: "How then do they get to the surface at all? Have they, since the earth settled down after Archæan times, been brought up in any appreciable quantity from great depths, or are we now dependent on the mere lateral segregation of small traces originally scattered residually through the outermost crust and left as the result of an imperfect gravitational adjustment when the earth passed from the molten to the solid state?"

Of the two rival theories, namely (1) that the metals have been brought from great depths in igneous eruptives, and (2) that the metalliferous deposits have been formed by the segregation of materials originally disseminated through comparatively superficial rocks, he remarks that they need not be mutually exclusive, and that they may be complementary; but after a consideration of the relative significance and merits of the two theories, he infers that only a small fraction of ore deposits show signs of transport from great depths, while the majority of those that are workable seem to be the result of simple lateral segregation, and even a large proportion of these are probably derived by segregation processes in the uppermost layers.

This view, which is probably the truth of the matter, so far as can be judged from the geodynamical evidence at present available, has an important bearing on the problem of the duration of supplies of metals. Supplies of lead, tin, zinc, and copper are likely to be exhausted long before those of coal and iron, and Sir Thomas Holland thinks it unjustifiable to take an optimistic view of the possibilities as regards aluminium, for bauxite deposits are few and small, and it remains to be proved that the metallurgical treatment of aluminium silicates is economically feasible.

In the concluding portion of his address he made some interesting remarks on the present condition of geology as a science. He clearly agrees with the editor of the New York *Engineering and Mining Journal-Press*, who told us recently that geological science is in the doldrums. Geological science, says Sir Thomas, is at present experiencing "a reposeful interlude"; it is indulging a "siesta." In his opinion the geological imago is more likely to emerge from its chrysalis stage at the meetings of the Institution of Mining and Metallurgy than at the meetings of the Geological Society. It would perhaps be wiser to expect any development that may affect geology as a science to be less sudden and spectacular than the emergence of an imago. The development is more likely to be gradual. Nothing could contribute more effectively towards the desired change than regular and joint meetings for discussion by the various societies interested. Is it too much to expect that the Geological Society, the Mineralogical Society, and the Institution of Mining and Metallurgy will one day establish permanent joint sessions and meet periodically, even if infrequently, to discuss topics of common interest? There is much uncultivated common ground between them. Dynamical geology, petrology, and mineral genetics require to be welded together into a scientific whole. By meeting periodically to promote the attainment of this end, each of the societies concerned would, while widening its own outlook, help forward the development of science. Now or never is the time to make this move, when three such able and intimate colleagues as Sir Thomas Holland, Prof. Watts, and Dr. Evans occupy the presidential chairs of the three societies chiefly concerned.

T. C.

The Discovery of Benzene.

By Prof. JOCELYN F. THORPE, C.B.E., F.R.S.

IT is a fact not generally known that Faraday's early work at the Royal Institution was mainly of a purely chemical character and that it was not until later, about 1831, that he took up the study of electricity and magnetism, the branch of physics in which his more famous discoveries were made and with which his name is usually associated in the public mind. It is evident, of course, that this bent towards the chemical side of science was determined by his early association with Sir Humphry Davy, for Faraday has left abundant records illustrating the influence Davy's lectures and personality had on him. He seems to have first attended these lectures in 1812 when, as a youth of twenty-one, he was still serving as apprentice to Mr. George Riebau, a bookseller in Blandford Street; later he sent Davy a copy of the notes he had taken, together with a letter in which he expressed a wish to abandon trade and adopt a scientific career. It was well for posterity that this letter did not meet the same fate as that of a similar one sent to Sir Joseph Banks, then president of the Royal Society, which remained unanswered; for Davy sent a kindly and encouraging reply which not only led to an interview between them, but afterwards to the offer of a post as assistant at the Royal Institution, the salary being 25*s*. a week with the use of two rooms at the top of the house; the minute of the Managers recording this appointment is dated March 1, 1813. Faraday did not, however, remain long at the Institution, for on Sir Humphry Davy relinquishing his appointment as professor of chemistry in 1813, Faraday accompanied him as secretary during a tour through Europe which occupied the next eighteen months.

It appears that Faraday had arranged with Davy prior to the tour that his post at the Royal Institution should be kept open for him, and to this he returned in April 1815, being in the following month appointed "Assistant in the laboratory and mineralogical collection and superintendent of the apparatus at a salary of 30*s*. a week," apartments also being granted him. From this date onward until the end of what may be termed the first period, which closed with his illness in 1830, his work was almost entirely of a chemical character. His illness seems to have prevented him from doing active work for nearly four years, and thereafter he devoted his genius to the development of electricity and magnetism, and seems to have abandoned all work on the purely chemical side. Nevertheless, during the earlier period he made many important discoveries, for it seemed impossible for this versatile man to touch any branch of science without enriching it. Indeed, the initial conception of many of the principles underlying colloidal chemistry, catalysis and the diffusion of gases was due to him.

Faraday's first original work was published in the *Quarterly Journal of Science* for 1816, and dealt with the analysis of native caustic lime. His own comment on this paper, printed in his volume on "Experimental Researches on Chemistry and Physics," is interesting, for he says: "I reprint this paper at full length; it was the beginning of my communications to the public, and its results very important to me. Sir Humphry Davy gave me the analysis to make as a first attempt in chemistry, at a time when my fear was greater than my confidence, and both greater than my knowledge; at a time also when I had no thought of ever writing an original paper on science." It is interesting to note, in view of the last remark, that during the next fifteen years he published as many as sixty important scientific papers, and that nine of these appeared in the Philosophical Transactions. An examination of the records shows, moreover, that he started his experimental work immediately on entering the Royal Institution, for in a letter to Benjamin Abbott dated April 9, 1813, that is, only about a month after his appointment, he described the work he and Davy had carried out on the composition of nitrogen chloride. During these operations both investigators seem to have received injuries from the many explosions that occurred, but with characteristic tenacity they succeeded in determining the specific gravity of the liquid and several of its properties.

One of the most striking of Faraday's earlier successes was obtained in his experiments on the liquefaction of gases, for in 1823 he was able to prepare chlorine, sulphur dioxide, carbon dioxide, sulphuretted hydrogen, euchlorine and nitrous oxide in the liquid state, free from water. The experiments were carried out at some personal risk, as the apparatus used was unsuited to withstand the pressure needed. He returned to this work twenty years later, and, adding cold to pressure, obtained ammonia, sulphuretted hydrogen, and nitrous oxide in the solid state. He had hoped to liquefy oxygen, and had subjected the gas to a pressure of 60 atmospheres at a temperature of $-140°$ F. without success. It was left to his successor to achieve this end, sixty years later, in the same Institution.

In 1821 Faraday was appointed Superintendent of the House and Laboratory at the Royal Institution, although it is curious that in a letter written to R. Phillips dated May 10, 1836, he states, "In the Spring of 1823 Mr. Brande was Professor of Chemistry, Sir Humphry Davy, Honorary Professor of Chemistry, and I, Chemical Assistant in the Royal Institution." Nevertheless, it is clear from the Managers' minutes that in February 1825 he was definitely appointed "Director of the Laboratory under the superintendence of the Professor of Chemistry." It was not until 1833 that he became the first holder of the Fullerian chair of chemistry. In 1820 he published the results of a most laborious and painstaking investigation on the alloys of steel, and in 1821 he described some new compounds of carbon and chlorine. In 1824, the year in which he was elected a Fellow of the Royal Society, he undertook, at the request of a committee appointed by the president and council, an investigation into the properties of optical glass.

The year 1825 witnessed the discovery of benzene, the centenary of which is now being celebrated. It appears that the Portable Gas Company condensed oil-gas (from fish oil) at a pressure of 30 atmospheres. A thousand cubic feet of gas yielded about one gallon of liquid hydrocarbons, and from these Faraday isolated a substance he called bicarburet of hydrogen, identical with the benzene of to-day. The importance of this discovery and its effect on the work of later investigators cannot be overrated. It showed, for example, that benzene is a product of the decomposition of natural oils, and led, indirectly, to the discovery made by A. W. Hofmann twenty years later that benzene could be obtained by the distillation of coal-tar.

Probably no single discovery has had more effect on the development of the past hundred years than this, for it has led not only to the establishment of new industries in all parts of the world with the consequent employment of millions of workers, but has placed in the hands of every one materials hitherto either non-existent or obtainable only by the well-to-do. Dyestuffs, perfumes, explosives, drugs, and similar modern commodities owe their existence to Faraday's discovery, because, once he had shown that a pure chemical substance could be produced by destructive distillation, the attention of chemists in all countries was directed to the possibility of obtaining others in the same way. Thus the isolation, in quantity, of benzene, toluene, the xylenes, naphthalene and anthracene from coal-tar was soon effected. Moreover, the influence which the discovery of the hydrocarbon had on the development of structural organic chemistry transcends that of any other substance, for benzene proved to be the keystone of "aromatic character" and the basis on which many natural products is built. The synthesis of natural indigo, to take one example of many, would have been impossible if benzene had been unknown.

It is true that Faraday had no idea whatever of the value of the discovery he had made. To him it was merely an interesting scientific fact which as soon as established ceased further to interest him. Indeed, things could not have been otherwise, because structural organic chemistry was then non-existent, and no one dreamt that there was any connexion between fish-oil and colour. But it is the pioneer who shows the way, even though he may not be able to or desirous of following it himself, and the sign-post erected by Faraday directed to a country full of rich and desirable things that could be utilised for the benefit of mankind. Fortunately, organic chemical science was served during the nineteenth century by a body of investigators who combined a clear and far-sighted vision with a manipulative skill which is the envy of their successors, and it was in their hands that Faraday's discovery was made to yield its full fruit.

In this way, therefore, one of the least of the discoveries of this great Englishman was destined to have a far-reaching effect on the civilisation of our race. Faraday, in a lecture delivered at the Royal Institution in 1816, spoke thus: "Before leaving this substance, chlorine, I will point out its history, as an answer to those who are in the habit of saying to every new fact, 'What is its use?' Dr. Franklin says to such, 'What is the use of an infant?' The answer of the experimentalist would be, 'Endeavour to make it useful.' When Scheele discovered this substance it appeared to have no use, it was in its infantine and useless state; but having grown up to maturity, witness its powers, and see what endeavours to make it useful have done." Surely nothing better than this could be said of his own discovery of benzene.

Current Topics and Events.

THE King's birthday honours list includes comparatively few names which are well known in scientific circles. Among them are the following: *Baronet*, Sir John Bland-Sutton, president of the Royal College of Surgeons; *Knight*, Prof. J. Robertson, Medical Officer of Health, Birmingham, and professor of public health in the University of Birmingham; *G.B.E.*, Sir Frederic Kenyon, Director and Principal Librarian of the British Museum; Sir John Snell, chairman of the Electricity Commission; *K.B.E.*, Dr. J. S. Flett, Director of the Geological Survey of Great Britain and the Museum of Practical Geology; *C.B.E.*, Dr. G. Rotter, Director of Explosives Research, War Office; Mr. F. A. Stockdale, Director of Agriculture, Ceylon; *O.B.E.*, Mr. W. Bevan, lately Director of Agriculture, Colony of Cyprus.

To an unsectarian gathering in connexion with the centenary meetings of the British and Foreign Unitarian Association, Lord Oxford and Asquith gave an address on "Some Phases of the History of Free Thought in the Nineteenth Century." From the contrasted lives of Robert Owen and William Cobbett, he illustrated the stimulus of free inquiry and open debate. Both men were pioneers in free and independent thinking, and Malthus was another who faced the facts careless of the hostility of his fellows. The search for truth continues to be the most imperious as well as the most stimulating of man's intellectual needs, and the form of the quest which we are accustomed to associate with the phrase "freedom of thought" is marked by independence of authority and by courageous facing of the facts wherever they may lead to in the way of conclusion. Freedom of thought marks the man of scientific temper though he may not have anything to do with what is conventionally called "science." Freedom of thought usually means the resolute exercise of scientific methods, but there is, as Lord Oxford indicated, a continual danger lest science become itself an authority that shackles freedom. Thus, he said, no greater misfortune has happened in the history of our vocabulary than that the same word "law" should be used to designate the command of a sovereign authority and the generalisations of a Newton or a Darwin. We wish that this lucid thinker had gone further in his analysis of what freedom of thought really means. Thus it is clear that, as secure scientific formulation advances, the field for freedom of thought must decrease. A formula that has stood the test of time and is verifiable by all normally constituted minds who can use the methods may be subsumed in a larger formula, but it can never be contradicted or scrapped. It is not the subject of legitimate free thought. Much of the so-called free thought of to-day is the expression of ignorance and vanity.

THE Inter-State Post-Graduate Assembly of the United States and Canada is an organisation to which nothing in Great Britain precisely corresponds. More than 500 of its members were formally welcomed in London on June 2 by the Duke of York, at the commencement of a long round of lectures and demonstrations by distinguished members of the medical profession in Great Britain. A growth of no more than nine years, the Assembly at once emphasises a need which the advance of modern scientific medicine makes more and more urgent as time goes on, and goes far towards affording the means for its satisfaction. It is significant that Dr. Charles Mayo, whose name is so closely associated with the highest specialism, should be the mouthpiece of his fellow-American visitors, of whom 65 per cent. are men in contact with the people as general practitioners, and that on several public occasions during the past week he has deplored the over-luxuriant growth of specialism in medicine and urged the importance of the "common or garden variety" of doctor. There may be many things that our hospital wards, operating theatres and laboratories can show our American visitors for their professional good; but if they turn our attention seriously to the problem of co-operation between the highly trained specialist, in theatre or laboratory, whom Dr. Mayo calls the "accumulator," and the "distributor" of medical wares, they will have done as great a service to British medicine as any we can render to them. Sir Humphry Rolleston has done well to direct attention to the urgency of the problem of post-graduate education in London. The members of the medical profession, he says, are students all their days and are naturally most anxious to keep up with the ever-advancing tide of medical knowledge. But effective means for doing this in London have yet to be thought out.

IT would be impossible to summarise here the many admirable papers read at the meetings of the Inter-State Post-Graduate Assembly. Some figures given by Colonel L. W. Harrison, of St. Thomas's Hospital, London, concerning venereal disease are, however, of general interest. Treatment during the last four years has reduced the new cases of syphilis from 42,000 to 22,000. New infections of gonorrhœa have diminished from 40,284 to 31,272. Although the number of attendances at clinics has increased, the cost has steadily diminished and in 1923–24 the estimate was 90,000*l.* less than in 1920–21, and the present cost is now $2\frac{1}{2}$*d.* per head of the population.

The reverse side of the picture is seen in the difficulty of ensuring treatment for the infected, particularly among women; and it is still possible for many cases to occur in which a woman gives birth to one syphilitic child after another in miserable sequence.

SINCE the departure of Capt. Amundsen from Spitsbergen on May 21 no news has, at the time of writing, been received from the expedition. While some uneasiness may be felt, there are no adequate reasons for supposing that he and his party have met with disaster. He may have reached the Pole and landed on the ice in order to take observations, and then found it impossible to rise for lack of level ice. It must not be forgotten that his heavily-laden aeroplanes required a run of about fifteen hundred yards before rising in King's Bay. In this event he is retreating on foot to Cape Columbia in Grant Land, where there is the first of several food depôts by which he could reach Etah in Greenland by the end of October and, after wintering, return to Europe next year. On the other hand, it is not impossible that, contrary to expectation, Capt. Amundsen continued his flight across the Pole to the coast of Alaska. In this event, some weeks might elapse before news was received from him. Another possibility is that he has found an extension of the Canadian Arctic Archipelago on the American side of the Pole and that he is engaged in exploration before he returns by air. There is little likelihood of both machines having crashed, and their non-arrival may reasonably be taken to indicate that Capt. Amundsen has, for one reason or another, changed his plans. If he is travelling on foot, no anxiety need be felt for so experienced a polar explorer, for although the food he carried would last only about a month, he could doubtless get a supply of seal meat with the weapons he took with him.

IN the pioneer work which led to the introduction of natural science into general school education, Clifton College played a very important part. At a time when chemistry and physics had not yet appeared upon the horizon of most schools, they were being taught at Clifton by men of the calibre of Profs. Debus and Worthington, Sir William Tilden and W. A. Shenstone, whose efforts were ably seconded by the then headmaster, Canon J. M. Wilson. When the present laboratories were erected, they were the best school laboratories in the British Isles. The rapid advances of the last thirty years, however, have rendered them inadequate and obsolete. The Council of the College has, therefore, decided to build a completely new science block, which seems likely to restore to Clifton its traditional position in the matter of accommodation for the teaching of science. The new buildings, which will stand on the site of the present Junior School, are to include two elementary and one advanced chemical laboratories, with similar provision for physics; a biological laboratory; four lecture rooms; research rooms for the head of the department and the senior physics master; a dynamo and battery room; a polarimeter room; a photographic dark room; a large science library; a physical geography room; and mechanics' workshops, etc. It is hoped that the buildings will be ready for use by September 1927.

THE second annual Report of the International Committee for Bird Protection (British Section) is a three-page pamphlet which briefly records the subjects which have been dealt with. These include the destruction of birds on Macquarie Island (south of New Zealand), the threatened extinction of the magnificent parrots peculiar to certain of the Lesser Antilles, proposed international measures for the protection of migratory species, certain aspects of the still persistent traffic in plumage, and the destruction of sea-fowl by oil. This last subject also forms the subject of a separately printed statement by the chairman, Mr. H. S. Gladstone. It is one of great importance, for not only birds but also fishes and other forms of marine life, not to mention the amenities of seaside resorts, may be threatened; international agreement and firm action are urgently required. It may be mentioned that the Section consists of representatives of all the principal British societies and bodies interested in ornithological study or in the preservation of wild life.

MR. HOWARD CARTER, in his discourse at the Royal Institution on Friday, June 5, on "The Tomb of Tut-ankh-Amen, from Ante-Room to Burial Chamber," said that he proposed to deal mainly with the work of the second and third seasons. He gave a brief account of the Valley of the Tombs of the Kings and some aspects of the first part of the discovery, and then described the more important funerary furniture discovered in the burial chamber and shrines. This includes a unique palace lamp carved out of pure semi-translucent alabaster; a triple-lamp of floral design, which would appear to be the prototype of the three-branched candlestick of the Christian era; golden emblems of Anubis; a perfume vase of the King and Queen; a cosmetic jar still containing its cosmetic plastic and fragrant; and the gold stick of the king. An account was also given of the great yellow quartzite sarcophagus discovered beneath the four shrines, with its four winged goddesses, Isis, Nephthys, Neith and Selk, sculptured at the four corners in high relief, and of the golden coffin found within. This coffin, of anthropoid form, yet to be examined, is no doubt the outer shell of a series of coffins, one within the other, the last containing the mortal remains of the young Pharaoh Tut-ankh-Amen.

THE Swiss Society of Natural Sciences is holding its hundred-and-sixth annual meeting on August 8–11 at Aarau on the river Aar in Switzerland. The scientific proceedings will be distributed over sixteen sections devoted to various aspects of science, and a number of lectures are announced in the general programme. These include addresses by Prof. P. Karrer (Zürich), on cellulose and artificial silk; Prof. P. Niggli (Zürich), on the structure of crystalline material; Dr. E. Gagnebin (Lausanne), on Wegener's theory of the origin of the continents; Dr. E. Witschy (Basel), on sexual differentiation; Prof. L. Léger (Grenoble), on biological features of mountain streams; and Prof. A. Vogt (Zürich), on the significance in medicine of research on inheritance. Excursions have been arranged to local places of interest. The president of the meeting is Dr. P. Steinmann, and the secretary, L. Kim, Aarau.

THE Italian Government and the International Institute of Agriculture have established a Joint Committee to organise a World's Forestry Congress, which will be held at Rome early in May 1926. Experts in forestry and representatives of the timber and allied industries are expected to attend from all parts of the world. The provisional programme of the Congress embraces a wide range of subjects, on which reports and papers will be read and discussed. This programme and the regulations may be obtained on application to the office of the International Forestry Congress, Villa Umberto, I, Rome (10). Persons of any nationality may take part in the Congress, as ordinary members, on payment of a subscription of 50 French francs, which will entitle them to a free copy of the proceedings and other publications issued by the Congress. At the same time there will be held, in connexion with the International Fair at Milan, an exhibition of forest products and of the machinery used in the conversion of timber, which should prove of great interest. Various excursions to Italian forests will be planned to follow on the conclusion of the meeting of the Congress.

THE thirty-sixth congress of the Royal Sanitary Institute will be held at Edinburgh on July 20–25. The Duke of York has consented to become honorary president, and the Right Hon. Sir John Gilmour, Bart., Secretary for Scotland, the president, will deliver his inaugural address on July 20. Already 675 delegates have been appointed from nearly 400 sanitary authorities from all parts of the British Isles; delegates will also be attending from Australia, India, South Africa, China, Egypt, France, Japan, the United States, New Zealand, Canada, Poland, and British West Indies. The meetings will be held in the University. The congress will meet in sections covering various aspects of sanitary science, and a number of conferences have been arranged. Among the subjects to be discussed are the Schick test and diphtheria, cancer, leprosy, and river and air pollution. The lecture to the congress will be delivered by Sir Leslie Mackenzie, and the popular lecture by Dr. Charles Porter. A Health Exhibition, including appliances for housing and general sanitation, and matters relating to health and physical welfare, will be held in the Waverley Market. Visits have been arranged to works and institutions in and around Edinburgh. The programme can be obtained from the Secretary, Royal Sanitary Institute, 96 Buckingham Palace Road, London, S.W.1.

THE science of protozoology—particularly that part of protozoology which deals with the parasites of man and animals—occupies such an important sphere in human organisation, that it is surprising that no journal devoted to its study has hitherto appeared in Great Britain. Protozoological papers have had to find a place either in periodicals of pure zoology or general medical parasitology, or else have had to find their way abroad. There has now appeared, however, under the title *Protozoology*, a journal devoted to the parasitic Protozoa, published from the London School of Hygiene and Tropical Medicine, and the first number is already on sale. It is a publication of the Institute of Agricultural Parasitology, which is under the direction of Prof. R. T. Leiper, who is also responsible for the *Journal of Helminthology*; and it is intended primarily to supply a medium for the publication of original communications on the parasitic Protozoa arising out of the work of the Institute. At present it is proposed that it should appear as occasion arises as a supplement to the *Journal of Helminthology*. The first part contains an article by Dr. J. G. Thomson on a species of Giardia found parasitic in the intestine of a parasitic Nematode. A curious feature connected with this is that no Protozoa were found in the intestine of the host of the worm—a viscacha—although the gut of the nematode contained so many flagellates as to suggest a culture. Miss M. Triffett contributes a most interesting paper on *Gastrocystis gilruthi*, a very common, though hitherto unsuspected, parasite of British sheep. The same author also has an article on various species of Coccidia found in snakes which were dissected at the prosectorium of the London Zoological Society. The articles are illustrated both by line-blocks and by half-tone plates. This new venture fills a very obvious gap in scientific literature, and we hope that it will meet with every success.

HIS Majesty the King will open the new house of the British Medical Association, in Tavistock Square, London, on Monday, July 13.

LORD BLEDISLOE, Parliamentary secretary to the Ministry of Agriculture, will open the new plant pathology laboratories at the Rothamsted Experimental Station, Harpenden, Herts., on Thursday, June 18.

DR. C. D. WALCOTT, secretary of the Smithsonian Institution, Washington, D.C., has been elected a foreign associate of the Brussels Royal Academy of Sciences.

WE regret to announce the following deaths:—M. Camille Flammarion, of the Observatory of Juvisy, Paris, widely known for his work and writings on astronomy, on June 4, aged eighty-three years; Mr. James Hunter Gray, K.C., a leading counsel in electrical, chemical and general scientific cases, on June 1, aged fifty-seven years; Prof. Omer Van der Stricht, professor of histology and embryology in the University of Ghent, on May 8.

WE learn from *Science* that the Thompson Gold Medal awarded by the National Academy of Sciences for distinguished service in the sciences of geology and palæontology has been given this year to Dr. John M. Clarke of Albany. The Medal, which was established for the purpose of recognising the achievements of long service, has been awarded but twice before, first to Dr. Charles D. Walcott, and second to Emmanuel de Margerie. Dr. Clarke was unable to attend the presentation ceremony on April 29, and it was with much regret that we recorded his death in our issue of June 6, p. 882.

THE Science Society of China has issued a pamphlet describing its organisation and equipment with illustrations of its headquarters, including its large science library and biological research laboratory at Nankin. The Society was founded in 1914 by some Chinese students in the United States. It was incorporated in China in 1917 and since then has grown steadily, and now numbers more than 700 members. The Government gave it some buildings in Nankin as headquarters and it has also centres in Pekin and Canton, and is negotiating for the establishment of a research physical institute at Shanghai. It holds an annual conference in the summer, and has several useful committees on scientific education in China and on scientific terminology. It issues a monthly periodical entitled *Science*. The pamphlet is written wholly in Chinese.

AN innovation at the Royal Botanic Gardens, Kew, is the issue of interesting series of postcards, reproductions in colours from photographs of living plants in cultivation in the Gardens. The first four sets of this series, comprising twenty-four cards, are now available from the Publication Kiosk near Museum III. in the Gardens. With sets of six cards of similar subjects, such as insectivorous plants, orchids, rhododendrons, etc., descriptive folders are supplied, the set with description being issued at the very reasonable price of 1*s*. The descriptions supply brief notes upon distribution, points of particular botanical interest, and occasional notes upon cultivation. The experiment is an interesting one, towards the popularisation of the floral treasures in the Gardens, and the cards, which can be purchased separately if required, should have a ready sale.

THE report of the National Illumination Committee of Great Britain for the year 1924 is concerned mainly with proceedings at the meeting of the International Illumination Commission, held in Geneva in July last. A list of definitions and symbols adopted at this meeting is given in the report, and it is mentioned that sub-committees on heterchromatic photometry, colorimetry, and a vocabulary dealing with illumination have been appointed. It is interesting to observe that the International Illumination Commission has approved in principle the adoption of the brightness of a black body, operated under specified conditions, as a primary standard of light, and the National Physical Laboratory has been asked to formulate suggestions for an accurate specification. International sub-committees dealing with the lighting of factories and schools and motor-car headlights have also been formed. Attention is also directed to the establishment of a sectional committee on illumination by the British Engineering Standards Association. Five sub-committees dealing respectively with photometers, nomenclature and symbols, illumination glass-ware, fittings and street lighting have been set up and are now holding meetings.

THE Report of the United States National Museum for 1924 records the accession of 362,942 specimens, this being well above the average (332,429) for the last fifteen years. The increase was particularly marked in the biological accessions and its value was enhanced by the scientific importance of many of the collections. Chief among these was the private collection of Dr. J. M. Aldrich, associate curator of insects, containing 44,610 specimens of Diptera, representing 4145 named species with type-material in 534 species. But in one way more notable was the transference to the National Museum of all the insect type-material in the custody of the Pennsylvania Department of Agriculture, comprising the holotypes of 14 species, cotypes of 6, and paratypes of 35. It is hoped that this example will be followed by other States, for, as it is justly urged, type-specimens deposited in a national museum are more accessible to specialists than when housed in State, or municipal, or private institutions, and are much safer since there is less likelihood of a change of policy. It may be added that the fewer the centres in which such material is assembled, the greater is the advantage to the serious student.

WE have received a copy of the second report of the Joint Benzole Research Committee of the National Benzole Association and Leeds University (1925). The report is divided into two sections, the first treating of the corrosion of brass and copper by benzole, and the second of the use of active carbon and silica gel for the recovery of benzole from coal and coke-oven gas (Bayer process). A complete bibliography for the years 1923, 1924 is included.

THE journals of F. Martens, the seventeenth-century naturalist traveller, are being republished by Dr. W. Junk, Berlin. His journey in the year 1671–1672 to Spain and the Canary Island was of less importance than earlier journeys to Greenland and Spitsbergen, but it enabled him to make a number of valuable observations. The journal is illustrated by many beautifully executed plates of scenery, plants, and fishes, but the editor has not added any notes.

NO. 47 of the Bulletin of the National Research Council of the United States consists of a classified list of Bibliographies of Physics published either as separate bibliographies or more commonly as references in books or in articles in scientific periodicals during the years 1910–22. The list has been compiled for Research Information Service by Dr. K. K. Darrow, of the Research Laboratories of the American Telephone and Telegraph and the Western Electric Companies. It has been found undesirable to follow the system of classification adopted in the International Catalogue of Scientific Literature, owing to the number of new subjects of investigation which have been opened up since that system was devised. Thus relativity, quantum theory, and radioactivity are included in the general physics, while the properties of α, β, and γ rays are treated under electricity. Where the bibliographical value of a book or an article is high, an asterisk is prefixed. As an example of the extent of the list, we may mention the section on X-rays, which covers 3 pages, and is classified under 20 headings. The whole list covers 95 pages and is followed by an index of 6 pages.

THE Cambridge Instrument Co., Ltd., is issuing convenient sized booklets describing the latest types of instrument which the firm produces. Booklets Nos. 3 and 4 are devoted to direct current and alternating current instruments respectively. Wherever possible, sensitivity data accompany the descriptions, and will prove helpful to intending purchasers. The figures given are not necessarily the best, but are those which can be easily obtained. A new form of Duddell oscillograph is described. It is easily portable and enables three simultaneous records to be obtained although only one source of light and one camera are required. Another novelty is the Campbell frequency meter. It should be of value in telephone work, as it enables accurate measurements of frequencies between 180 and 4000 cycles per second to be made. The condition of balance is indicated by silence in a telephone, and the frequency is found by multiplying the reading on the scale by a simple factor, depending on which of the five ranges is used. Various types of apparatus suitable for telephone engineers are made, and electrical engineers will be interested in the fault localiser, the lightning conductor bridge, and the Epstein testing square.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: a lecturer in mathematics and mechanics at the Stockport Technical School—The Principal (June 24). Three assistant inspectorships in connexion with agricultural, dairying, and horticultural education and research (two with practical experience in agriculture and who have specialised in dairying, and one who has specialised in horticulture)—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (June 29). An assistant chemist at the Fruit and Vegetable Preservation Research Station of the University of Bristol, at Campden, Glos.—The Registrar, University, Bristol (June 29). A microscopist at the Technological Research Laboratory of the Indian Central Cotton Committee, Bombay—The Secretary, Indian Central Cotton Committee, 25 Wodehouse Road, Fort, Bombay (July 5). An assistant in biology at University College, Galway—The Secretary (September 18). Assistant entomologists under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. Keeper of the laboratory of the Royal Horticultural Society at Wisley—The Director, R.H.S. Gardens, Wisley, Ripley, Surrey.

Our Astronomical Column.

ORKISZ'S COMET.—Prof. Banachiewicz and his assistants have made a careful study of the orbit of this comet, using 80 observations extending from April 3 to May 27.

$$\begin{array}{ll} T & \text{1925 April } 1{\cdot}4782 \text{ G.M.T. (new)} \\ \omega & 36^\circ\ 9'\ 15'' \\ \Omega & 318\ \ 3\ \ 11 \\ i & 100\ \ 0\ \ 46 \\ \log q & 0{\cdot}04505 \end{array} \left.\begin{array}{l} \\ \\ \\ \end{array}\right\} 1925{\cdot}0$$

Actually they give the elements not in the above form, but in *Cracovians*, a name that they have given to the direction cosines of the major and minor axis of the orbit, and the normal to the orbit plane. It is shown that some of the computations are simplified by using this form. No appreciable deviation is found from a parabola, so identity with the comet of A.D. 1500 is excluded. The following outline ephemeris is given:

	R.A.	N. Decl.
June 4.	$6^h\ 15^m\ 57^s$	81° 38′
July 6.	10 10 15	60 57
Aug. 7.	10 54 24	47 49
Sept. 8.	11 23 55	40 11

THE KODAIKANAL OBSERVATORY IN 1924.—The report of the Kodaikanal Observatory for the year 1924 emphasises the importance of this observatory for solar work. Photographs on a scale of 8 inches to the sun's diameter were taken on 328 days. Monochromatic images of the sun's disc in K light were obtained on 329 days, prominence plates on 290 days, and photographs of Hα disc plates on 294 plates. Three important features are brought out on the last-mentioned plates, which appear to be typical of sunspot disturbances. An account of these was recently presented to the Royal Astronomical Society by Dr. T. Royds. They are (1) a bright ring round the sunspot; (2) outside this a dark flocculus more or less extensive; and (3) between the dark flocculus and the coarse réseau of the general undisturbed surface of the sun there is a bright surround consisting of bright patches larger than in the general réseau, interspersed by dark features sometimes suggestive of the spot vortex. The study of these phenomena is being continued. The sunspot activity showed a steady increase since the previous year, the approximate mean latitudes of the spots being 23°·7 in the northern hemisphere and 24°·9 in the southern. In the laboratory a series of comparisons of the solar spectrum with arc spectra was obtained for subsequent measurement for displacement of the solar lines.

SPECTROSCOPIC PARALLAXES.—It is interesting to note that the Stonyhurst College Observatory has published its first paper on spectroscopic parallaxes (Monthly Notices R.A.S., vol. 85, p. 444), and the author, the Rev. H. Macklin, gives the values for 30 stars. He explains that as only stars not fainter than about the third or fourth magnitude gave spectra intense enough for this purpose with the Stonyhurst instruments, sufficient material is not yet available for more than a preliminary examination. The intensity-differences between the lines are measured by a wedge, the method adopted by the Norman Lockyer Observatory. At the latter observatory the luminosities and spectroscopic parallaxes of 1025 stars of types Fo to Mb, and 200 stars of type B, have already been published, the last 100 B-type stars appearing in the same issue of the Monthly Notices.

NEW LUNAR MAP.—Mr. H. Percy Wilkins has in preparation a lunar map of 200 inches in diameter in sheets of 22 × 30 inches. The detail is taken from all published drawings and notes, namely, Weinck, Elger, Gaudibert, Goodacre, Schmidt, and photos from Paris, Lick, Yerkes, and Mount Wilson. Objects down to half a mile in diameter are included. The sheets will be issued separately, so that any one requiring, say, the sheet containing Plato can have it without the others.

Research Items.

NEOLITHIC AGRICULTURAL IMPLEMENTS FROM CHINA.—In *L'Anthropologie*, T. 35, Nos. 1-2, P. Licent and P. Teilhard de Chardin describe two stone implements from an important neolithic site at Linn-Si, N.E. China, which are not only noteworthy in themselves but have a direct bearing upon a question of dating raised by Dr. Andersson in connexion with an implement found at Kalgan. The two implements in question are respectively 272 mm. long, 115 mm. broad, maximum thickness 16 mm.; 355 mm. long, 117 mm. broad, maximum thickness 26 mm. The latter differs from the former in being polished. Certain well-marked abrasions suggest that both were fitted with handles, and it is probable that they were used as hoes. The implement found by Andersson, which resembled the unpolished implement from Linn-Si, impressed him by its Solutrean style, and he suggested that it might point to an upper palæolithic in China; but it is now clear that it must be classified as neolithic. A further point which emerges is the close affinity of these agricultural implements with those of North America. This had already been pointed out by Andersson in the case of the Kalgan implement, and is supported by Mr. Moorehead after an inspection of the Linn-Si specimens. They may therefore afford further proof that North America was peopled from Eastern Asia.

PHYSICAL CHARACTERS OF THE AUSTRALIAN ABORIGINES.—Dr. F. Wood-Jones and Dr. T. D. Campbell have published in the Transactions of the Royal Society of S. Australia, vol. 48, anthropometric observations, comprising thirty-five measurements in all, of ten South Australian aborigines, eight Kookata from the Stuart Ranges, of whom three are females, and two, a male and female, Ngunga from Streaky Bay. The skin colour varied from light to very dark chocolate, the eyes were dark or medium brown, the hair was black (except in two cases in which it was white) and wavy, though in two cases approaching straight. The head in length ranged from 165 to 200 mm., breadth from 130 to 146 mm., being dolichocephalic in all cases, and in height from 112 to 135 mm. To these measurements have been added measurements from various sources which bring the total number of individuals up to nearly two hundred. As a result of the comparative study of these figures, so far as at present completed, it is apparent that the Australian aboriginal is uniformly dolichocephalic, remarkably platyrhinic, has long forearms, and remarkably long legs from the knee downwards.

THE TRICHOCYSTS OF PARAMECIUM.—Mr. J. T. Saunders (Proc. Cambridge Phil. Soc., Vol. I., No. 4, April 1925) has investigated the trichocysts of Paramecium and concluded that they are the means by which this ciliate adheres to surfaces. When Paramecia are attracted, chiefly by the P_H of the water, to a particular spot, adherence takes place. The extrusion of the trichocysts is due to slight pressure such as may be set up by the Paramecia colliding with an object in the water. Verworn's view that the trichocyst consists of semi-liquid material which hardens on being extruded into water is adopted. The author shows that the tip of the trichocyst thread is sticky but the rest of it is not. Ciliary motion does not cease when Paramecium is attached by its trichocysts. The speed of movement, which is dependent on ciliary activity, is reduced when the P_H of the water reaches 8·0, and this reduction in ciliary activity results in the slender trichocysts being able to hold the organism fast. A further increase in the P_H of the water above 8·0 reduces the speed of the Paramecium so much that the force of the collision with an object is insufficient to cause expulsion of the trichocysts.

GOLGI APPARATUS, MITOCHONDRIA AND NUCLEI.—Dr. R. J. Ludford (Journ. R. Micr. Soc., March 1925) describes an improved technique the new feature of which is the employment of water at 35° to 38° C. for bringing about the reduction of osmic acid for demonstration of the Golgi apparatus. Dr. Ludford states that this method results in much less non-specific reduction than when the osmic acid is heated. The original paper should be referred to for details.

A GENETICAL STUDY OF THE FLAX PLANT.—A beautiful example of the application of pure science to practical problems is supplied by the very clear paper of Adelaide G. Davin and G. O. Searle, which appears in the Journal of the Textile Institute, Vol. 16, pp. T. 61-82, March 1925. As the result of extensive correlation studies they conclude that by ordinary selection methods it should be possible to isolate varieties of flax which are genetically distinct as to (1) flower colour, (2) time of flowering, (3) percentage of fibre, (4) length of stem, and (5) mean number of seeds per capsule. Also that it should be possible to breed new varieties of flax combining the qualities of tallness, high percentage of fibre and high mean number of seeds per capsule. From the practical point of view perhaps the most important facts appear to be the inheritance of variations in percentage of fibre and the fact that tall stemmed varieties contain more numerous fibres in each bundle of sclerenchyma, the fibres therefore being individually of relatively small diameter and with small open lumen. Probably such bundles of fibres have particularly valuable spinning qualities.

DROUGHT-RESISTANCE OF PLANTS.—It has been supposed that xerophytic plants are able to resist drought mainly by the reduction of their transpiration through special adaptations, such as hairs, thickened epidermis, and so on. N. A. Maksimov has studied the problem for several years, and according to him (*Journal of Experimental Agronomy*, Moscow, vol. 22, 1923) this is not the case. He has found, in fact, that the transpiration of xerophytes is, as a rule, far more extensive than that of typical mesophytes. Thus, xerophytes cannot be regarded as plants which are able to thrive under very dry conditions because of adaptations preventing loss of water through transpiration; their ability to resist drought depends not on their morphology or anatomy, but on some purely physiological characters. Amongst the latter most important are: (1) the high osmotic pressure of the juice in cells causing a powerful influx of water through roots; (2) the probable presence of special compounds preventing plasmolysis; (3) wilting of xerophytes occurs with a lower water-content than in mesophytes.

THE MORPHOLOGY OF THE CARPEL.—The traditional interpretation of the gynæcium of the flower as simply consisting of the union of modified carpellary leaves, by their margins when the ovules are parietally borne, by their folded flanks when the placentation is axile, with alternative suggestions as to the axial or carpellary origin of the central strand when this is left free from the ovary wall, is now under serious critical examination, thanks to the work of Miss Edith R.

Saunders. In a paper upon carpel polymorphism in the *Annals of Botany*, vol. 39, 1925, pp. 123-167, Miss Saunders gives reasons for thinking that widespread throughout the group of Angiosperms three different types of carpels can be found, all of which contribute to the making of the Angiosperm gynæcium. She distinguishes these three types as—(1) the valve carpel, which retains the traditional leaf form, a row of ovules being borne upon each foliar margin; (2) the solid carpel, which in its most reduced form is nothing but a fibro-vascular cord with a few lateral veins. (Such a carpel may project into the ovary cavity, giving rise to such a partition as the replum of the Cruciferæ. When solid carpels are associated with valve carpels in a gynæcium, they are usually fertile and the valves sterile); (3) the semi-solid or pseudo-valve. In this type the valve contour is maintained, but the placentæ, instead of lying at the margin, are displaced to the neighbourhood of the central line and the vascular system also consists of a double strand running in close connexion with the funicles of the ovules. Many anomalies of stigmatic and stylar structure and arrangement receive a new interpretation at Miss Saunders' hands by means of these new conceptions of polymorphism in carpellary structure. Doubtless this new view-point will be thoroughly examined by students both of floral morphology and systematics.

THE DISTRIBUTION OF RADIOACTIVE SPRINGS.—Seventeen springs in the Velay region of the Haute-Loire have been examined by M. A. Baldet (*C. R. Acad. d. Sci.*, Paris, March 30), who found that only three of them showed any considerable radioactivity. The three streams in question lie practically in a straight line, the length of which is 44 km.; and more recently a fourth radioactive spring has been discovered, in the former bed of a stream the course of which has been diverted by floods. The new spring lies in the same straight line as the other three, so that it seems very probable that the distribution is not fortuitous, but that there is really a kind of long geological axis along which the strongest radioactivity of the region is distributed. This axis is nearly parallel to numerous lines of fracture in the surrounding country and to two ranges of volcanic hills. An extinct volcano lies on the axis near one of the springs, as do portions of two river valleys.

SPELLS OF ABNORMAL WEATHER.—The presidential address to the American Meteorological Society by Mr. Willis I. Milham dealt with "The Causes of Abnormalities," taking especially the year 1816, which in America has been styled "the cold year," and is often called "the year without a summer." The address is printed in the *Monthly Weather Review* for December. Much has previously been written about this year, which, as a whole, is said not to have been "record-breakingly cold," but was chiefly exceptional for a very cold summer. The possible reasons why 1816 was abnormal are considered. There had been the violent volcanic eruption of Tombozo in April 1815, which ranks with the four or five largest during the last two centuries, while a weak sun-spot maximum also occurred during 1816. For the 23-year period 1816–1838, July 1816 had the lowest temperature on record and both May and June were the second coldest, while from March to September the monthly temperatures were below the normal. For another abnormality the warmth in America of December 1923 is considered, and it is suggested that possibly some change in ocean-surface temperature over a large area was the cause. At Greenwich, December 1923 was about 1° colder than the normal. Mr. Milham alludes to the "crying need for a weather map of the whole northern hemisphere, if not for the world." For some years now, 1910–1917, such weather information for the world has been published by the Meteorological Office, Air Ministry. In support of Mr. Milham's address it may be mentioned that in London the mean shade temperature in 1816 was 53° F. in June, or 5° below the normal for 150 years; 54°·5 F. in July, 7° below the normal; and in May and August the deficiency was respectively 3°·6 and 3°. The July mean was the lowest on record. June 1909 and 1916 are the only two Junes with temperatures so low as that of 1816. In every month during 1816 except September and October the mean temperature in London was below normal.

COLOUR CINEMATOGRAPHY.—Mr. Claud Friese-Greene recently described his process of colour cinematography before the Royal Society of Arts, and his lecture is printed in the Society's Journal for May 1. It is a two-colour process, and the two colour images alternate on a single film, so that ordinary projecting machines suffice for showing them. An ordinary motion picture camera has added to it behind the lens a rotating disc with two apertures in it, one filled with a colour filter that passes a very broad band of the red end of the spectrum, and the other filled with an opaque material except for a small opening that allows white light to pass and a "small portion of filter also passing light from the red end of the spectrum"—"in fact a pale yellow." In the positive print, the pictures corresponding to the first are dyed orange-red and the others are dyed blue-green. The advantages of the method are that the tendency of greens to show of a brownish tint in two-colour processes is avoided, the cost of the prints is less than one farthing a foot more than that of ordinary black and white films, and "the time in turning them out" is practically the same. Several examples were shown, and during the discussion that followed the lecture Mr. Colin Bennett said that "the results were appreciably better than those arrived at by other commercial methods of colour cinematography."

PHOTO-ELECTRIC CONDUCTIVITY IN ROCK SALT.—The phenomena of photo-electric conductivity in rock salt crystals which have been coloured yellow by the action of X-rays, are similar in many respects to those which have been observed in the diamond and other crystals with high refractive index. They are described by Dr. B. Gudden and Dr. R. Pohl in the *Zeitschrift für Physik* of March 17. Their observations were made in an electric oven, at temperatures of 30° to 40°, 60° to 80°, and 100° to 130°, the crystal being illuminated with light of short wave-length (405 and 436 $m\mu$ lines of mercury) with a potential difference of 800 volts applied to the electrodes. At the lower temperatures the crystals are insulators when not illuminated. The current starts without inertia as soon as the illumination commences, and drops at once nearly to zero when it ceases; this current is regarded as being due to the flow of electrons which have jumped from the phosphore particles, after absorbing radiant energy, leaving them in the excited state. If now the crystal is illuminated with infra-red light, there is a rush of current, which quickly drops to a low constant value; this is regarded as being due to the drop of electrons, coming from the cathode side, into the positively charged phosphore molecules. At the higher temperatures this action is facilitated by the thermal movements of the molecules, and at 100° to 130° there is practically no jump in the current when the red illumination is started, since there are no excited centres left when this takes place. Phosphorescence takes place when the second component of the current flows.

REFRACTIVE INDEX OF A MIXTURE.—Although there have been many attempts to establish a formula by means of which the refractive index of a mixture of two liquids could be calculated from the indices of its constituents and the amounts of each present in the mixture, none of them has been found applicable to all cases. In the issue of the *Physikalische Zeitschrift* for April 21, Prof. K. Lichtenecker claims that if the mixture involves no contraction, its refractive index μ may be calculated from the refractive indices μ_1, μ_2 of its constituents and the volumes v_1, v_2 of the constituents present in 1 c.c. of the mixture by the formula

$$\log \mu = v_1 \log \mu_1 + v_2 \log \mu_2.$$

If contraction occurs on mixture, the value of $\mu - 1$ as calculated from this formula is increased in the ratio of the increased density to the density to be expected on the linear law from the densities of the constituents. So far, the new law has been tested on few mixtures, but for them it has proved correct to within one part in 10,000.

MEASUREMENT OF IONIC MOBILITY.—The April issue of the Journal of the American Chemical Society contains two papers by D. A. MacInnes and co-workers on the measurement of transport numbers by the moving boundary method. In the first paper a simple form of apparatus is described in which two sharp boundaries are readily obtained at each electrode; the apparatus is very suitable for use in university courses. Experiment shows that the results should be calculated from rates of movement of the two boundaries separately; it is not safe to rely on the ratio of the movements. In the second paper the apparatus previously described is improved and measurements made of the transport numbers of the anions in 0·1*n* solutions of potassium, sodium, and hydrogen chlorides. The results were 0·492, 0·3865, and 0·8320, respectively. The product of the transport numbers of the chloride ion and the corresponding equivalent conductivities for the solutions is constant, which shows that the salts in these solutions have equal degrees of dissociation at 25°. Previous work shows that the same holds at 18°. This dissociation is considered to be complete, so that the influence of concentration on equivalent conductivity is due to changes in mobility rather than in the number of ions.

ORGANIC SYNTHESES.—The suggestion has been made that "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, can increase its scope of usefulness by making available directions for preparations which have been submitted for future volumes. The following is a list of some of the preparations which are now being checked by the editors. Those who wish a copy of directions for some of the listed preparations can procure the same by writing to Henry Gilman, Iowa State College, Ames, Iowa. Acetamidine, acrolein, benzal pinacolone, benzylaniline, *m*-bromobenzyl chloride, *o*-bromotoluene, α-cyano-β-phenylacrylic acid, cyclohexyl-bromopropene, furoic acid, hydroxylamine base, *p*-iododimethylaniline, *p*-iodoguaiacol, mandelic acid, 1-methyl-2-pyridone, myristic acid, naphthaldehyde, phenyl isothiocyanate, symphthalyl chloride, propionaldehyde, pyromellitic acid, pyrrol carboxylic acid, thiophosgene, thymoquinone, *o*-toluamide, *m*-tolylene diamine, viscose.

MEASUREMENT OF RADIO SIGNAL STRENGTH.—The first accurate measurements of radio signal strength were made so far back as 1905 by Duddell and Taylor. An immense amount of experimental work has since been carried out all over the world. Many semi-empirical formulæ have been suggested for predetermining the signal strength, but they only apply roughly for a given range and for a given wave-length. An important paper on this subject by Capt. Round and his colleagues in the Marconi Co. was read to the Institution of Electrical Engineers on May 6. They give a complete report of the measurements made on signal strength over great distances during 1922 and 1923 by an expedition sent to Australia. They apply the latest scientific formulæ to their observational data, but with only very indifferent results. The complete theory of world transmission by radio has yet to be given. It is pointed out that at great distances the signals go round the earth in both directions, producing interference and "beats" in the receiver. The attenuation of the signals is less during night time, and so a louder signal may come by the long path. For example, with the American signals a bi-directional effect was clearly produced at a distance of only 13,000 kilometres from New York. A study of the Australian signal measurements leads to interesting conclusions. It was found that, in general, when using long wave-lengths, the signals going by the west to east path were stronger, and those going by the east to west path were weaker, than was expected. In the case of the Bordeaux signals the ratio was 5 to 1. In the case of transmission across the Atlantic, transmission from America to England is undoubtedly better than transmission in the reverse direction. This fact appears to contradict the usual reciprocal relations of optical theory, and the authors look to the future for the observational data still requisite before the phenomenon can be explained.

MEASUREMENT OF WATER DISCHARGE THROUGH SLUICES.—There has just been issued, in booklet form, two papers, by Dr. H. E. Hurst and Mr. D. A. F. Watt, of the Physical Department, Egyptian Public Works Ministry, presented to the Institution of Civil Engineers, in 1924, dealing with the measurement of the discharge of water through the sluices of the Assuan Dam. The first paper details certain experiments made to determine the similarity of the motion of water through sluices and through scale models, and the second is a record of actual measurements of the Nile during its higher stages made by a method depending ultimately on direct volumetric computation by means of a masonry tank. In the first paper, the authors conclude that the discharge of large sluices can be determined from models with an average accuracy as good as that obtainable by current meter measurements, the scale of the model to be adopted depending upon the product of the velocity in the actual sluice and its linear dimensions. They state that the limit of smallness in their investigations occurred with weir conditions when the head above the sill was about 3 cm., the depth about 2 cm. at the gate, and the velocity about 0·4 m. per sec. They suggest that until further experiments are made over a wider range, it would be well to keep the product of velocity, in centimetres per second, and smallest dimensions of the orifice, in centimetres, above, say 100, and in general not to use orifices of less than 3 cm. in their smallest dimension. In the second paper, it is stated that the method employed for measuring the flow of the Nile was to use current-meters of specially stout construction to plot the velocity-distribution in the types of sluice used to pass the flood. Useful results were obtained which showed that current meter measurements agree closely with sluice measurements, and, therefore, that the uncertainty about the correctness of current meter results in a deep and rapid stream is largely removed.

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

By Dr. HENRY FAIRFIELD OSBORN,

Senior Geologist, U.S. Geological Survey; Hon. Curator Vertebrate Palæontology, American Museum of Natural History; Research Professor of Zoology, Columbia University.

"Discussions of evolution came to an end primarily because it was obvious that no progress was being made. . . . We became geneticists in the conviction that there at least must evolutionary wisdom be found. . . . The discontinuity of variation was recognised in abundance. Plenty of the Mendelian combinations would in nature pass the scrutiny of even an exacting systematist and be given 'specific rank.' In the light of such facts the origin of species was no doubt a similar phenomenon. . . . We cannot see how the differentiation into species came about. Variations of many kinds, often considerable, we daily witness, but no origin of species. . . . That particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious." (William Bateson: Evolutionary Faith and Modern Doubts. Address in Toronto, December 28, 1921.)

IN the early part of the nineteenth century the geologists Hutton and Lyell, the masters of Darwin, overthrew the cataclysmic hypothesis of earth formation by the new uniformitarian doctrine in geology, "We must interpret the past by the present." Now is the time in biology to reverse this doctrine and demonstrate that we must *interpret the present by the past.* This we owe to the discovery of continuous genetic phyla of both invertebrate and vertebrate animals, in which the evolution of the germ-plasm can be continuously traced.

As distinguished from all observations in zoology, we deal in palæontology with secular evolution, *in which we observe the adaptive action and reaction of the heredity germ over long periods of time.* We also observe the secular action of natural selection (Darwin's selection factor), the secular direct reaction to environment (Buffon's factor), the secular adaptive action of habit (Lamarck's factor), the secular adaptive reaction to the living environment (Darwin's factor). As developed between 1893 and 1915 by Osborn, we must sharply separate Darwin's factor of selection, which has no energy content, and the above four energetic forces of evolution, namely, heredity, physical environment, living environment, and individual development or ontogeny.

Every organism develops through the normal interaction of these four forces; if either force is not normal the organism is not normal; if either force is progressive the organism will tend to be progressive; if either force is retrogressive the organism will tend to be retrogressive in the same manner. Whereas in the transmutation of chemical elements and evolution of form in all the inorganic universe we have to do only with the action, reaction, and interaction[2] of internal forces and external forces, in the transmutations of life we have to do with these *four* complexes of energy: first, the internal potential energy of heredity as observed in phylogeny; secondly, the internal energy of the developing organism as observed in ontogeny; thirdly, the external energy of the physical universe known as environment; fourthly, the rapidly multiplying energy of surrounding plant and animal organisms, known as the biota. From the beginning of life every typical organism is invariably developed under this quadruple principle, which is termed tetrakinesis in application to function, tetraplasy in application to form. Thus, whereas inorganic transmutation may be twofold in its elaborate complexes of energy, organic transmutation is invariably fourfold in its elaborate complexes of energy.

Herein lies the first distinction between inorganic and organic evolution. The second distinction is that before life appeared, the inorganic physico-chemico-mechanical content of our planet was exactly the same. Not a single combination of energy and matter in the entire planet was capable of resisting shock, of repairing waste, of combating disintegration, of co-ordinated resistance; consequently, the structural history of the inorganic planet was one of alternate construction and destruction. The third distinction is that while the evolution of life advances by physical, chemical, and mechanical methods which we may more or less definitely measure and observe, this is only a half-truth, because living mechanisms differ from lifeless mechanisms, no matter how perfect, in being more or less self-adapting, self-repairing, self-perfecting, self-regenerating, self-modifying, self-resourceful, self-experimental, self-creative. It is observed that these self-adaptive powers lie solely in the internal potential energy of heredity, while they may be evoked as reactions to changing physico-chemical environment, to ontogenetic experience, to the changing biota of animal and plant life. Organs, tissues, and cells that have lost connexion with the heredity germ-plasm wear out exactly like other machines.

Consequently, the prefix *bio* is essential; in living things we are dealing with bio-physical, bio-chemical, bio-mechanical phenomena. Life has a bio-physico-chemico-mechanical basis.

The primary relation of these four bio-physical, bio-chemical, bio-mechanical actions and reactions, all involving energy, to Darwin's non-energetic principle of natural selection may be illustrated in the annual migration of the golden plover, *Charadrius dominicus.* Numbers of this species winter in Hawaii, where the oceanic climate is singularly uniform the year around, with no violent changes of season. The inborn impulse to northern migration is chiefly a bio-chemical process; the inborn sense of direction that guides the bird northward over two thousand miles of open ocean is chiefly a bio-physical process; the flight is bio-mechanical so far as the heart, the circulation of the blood, the bones, and the muscles are concerned, but bio-chemical in its energy supply. Under the severe struggle for existence all atypical plover probably drop into the sea, but under bio-mechanical self-adaptation every plover that completes the flight to the nesting-place is improved thereby, and in this process the whole race is annually standardised. This crucial, dominant bio-physical, bio-chemical, bio-mechanical period of flight transfers the bird into the breeding grounds, where new principles of natural selection prevail, especially in all the bio-chemical activities of the plover.

In this plover story we illustrate two fundamental principles of biology: first, as the primordial part of the process, the tetraplastic principle of the animal

[1] Address delivered before the National Academy of Sciences, Washington, on April 28.

[2] From E. B. Wilson's "The Physical Basis of Life" we quote a few lines embodying our idea of *reaction*: "No conception of modern biology offers greater promise for the physico-chemical analysis of vital phenomena than that the cell is a colloidal system; and that what we call life is, in the words of Czapek, a complex of innumerable chemical reactions in the substance of this system." Also of *interaction*: "It has been proved that the individual unit often affects the production not merely of one character, but of many. The converse probability is shaping itself that the production of any single character requires the co-operation of several or many units, possibly of all. . . . Every unit may affect the whole organism and all the units may affect each character. . . . The whole system may be involved in the production of every character."

mechanism developed by Osborn between 1893 and 1918, that all typical organisms depend upon the typical action, reaction, and interaction of the four complexes of energy, physical, chemical, mechanical. Secondly, (*a*) Darwin's selection principle, whereby all organisms are constantly standardised in their adaptive actions, reactions, and interactions; (*b*) subsidiary to this, the Osborn-Baldwin-Morgan principle (1896–1898) of "coincident selection," whereby through heritable potentialities of self-improvement, self-adaptation, etc., every race of organisms is not only standardised but also constantly improved; (*c*) the negative of Darwin's principle, the "cessation of selection" or panmixia of Weismann, whereby there is a gradual recession of unused or less used organs from a dominant to a subsidiary position in the life of the organism, finally to retention only in the germinal stage; (*d*) the internal bio-mechanism of selection, the "intra-selection" of Roux, whereby every element in the developing organism also has to contribute its quota or decline.

While intensive observation by palæontology of successive genetic phyla of organisms demonstrates that the chief selection principle of Darwin is constantly operating in the rise and decline of all adaptive bio-mechanical organs, the subsidiary fortuitous selection hypothesis as originally conceived by Darwin leaves the greater part of the bio-mechanical evolution process entirely unaccounted for. While we palæontologists observe great currents of continuous bio-mechanical adaptation which are actually going on in the heredity germ-plasm, we find no evidence either of chance or of discontinuity in the whole domain of bio-mechanical evolution. The surface ripples of fortuity as observed in De Vriesian mutation and the occasional waves of heritage variation observed in botany, zoology, experimental embryology, and genetics do not blind us to the continuous adaptive bio-mechanical evolution of each organism, even to the minutest bio-mechanical detail in each organ.

This statement is borne out in a recapitulation of the chief bio-mechanical principles of adaptation formulated from the time of Aristotle and of Empedocles to the present time, five of which were first observed in zoology and confirmed in palæontology, the remaining four principles having been observed only in palæontology.

(*To be continued.*)

Periodicities and Predictions.

AN interesting paper by Prof. Axel F. Enström, Director of the Academy of Engineering Science, Stockholm, under the title "On Periodicities in Climatic and Economic Phenomena and their Co-variation," deals with the important question of extrapolating past climatic and economic data in order to predict future conditions. In his introduction the author claims that "an investigation along these lines of the coal prices and the general prices" published by him in 1913 has been justified by the prediction of an economic boom about 1918 and a depression with the bottom about 1922. But it is doubtful whether this success really affords a corroboration, for these events must have been mainly controlled by the termination of the War, and were forecasted by methods independent of such an upheaval.

It is rather surprising that the author "earnestly warns" his readers against the "absolutely unreliable" process of drawing a mean straight line through a graph of annual values and producing it; for the advantages and disadvantages of the method lie on the surface, and there are occasions when it may give useful information.

Prof. Enström points out that the ordinary plan of smoothing, say by 5 years, effects a bigger reduction in the amplitude of the shorter periods than it does in the longer: on the other hand, if we subtract each term of a series from the next the series of differences is free of secular change and the amplitudes of terms of short period grow by comparison with those of long period. So when he is examining the temperature of London in relation to a period of about 9 years, which he calls the ϕ period, he smooths with respect to periods of 2, 3, 5, 11, and 13 years, and takes differences three times: and in order further to bring out the ϕ component he subtracts from the resulting series that got by smoothing over 9 years; he then applies an elaborate correction (including a smoothing by 19 years) for the sake of the residual terms. As we should expect after so much selective treatment, the graph is strikingly cyclic, though there are irregularities; and the author's conclusion is that the ϕ period is "not a homogeneous sine-wave of constant wave length but possibly a compound wave": there is, however, no comparison of the amplitude with what would be given by a purely accidental set of data, and no Fourier analysis of the periods between 8 and 10 years. The question whether the period is compound is left unsolved.

In order to obtain a real basis for extrapolation in regard to the future, it seems clear that the series must be replaced by a number of harmonic terms, and extrapolation can only be made when it is shown that the series of harmonic terms gives a fair approximation to the original. The analysis of Prof. Enström appears rather complicated for the small amount of definite information that it provides regarding Fourier periods in the neighbourhood of 9 years.

A further departure is made in relation to "co-variation." After determining curves for the ϕ periods of two quantities in the manner already described, the correlation coefficient between these curves is obtained: as might be expected from the inevitable similarity, high coefficients are derived when the data of one curve are advanced or retarded so as to produce coincidence of phase: and obviously it is misleading to speak of these results, got by a process that in general removes most of the character from the original curves, as if they were derived direct from the originals themselves. Thus it appears very unlikely that the variations of the yield of wheat in France are to any serious extent controlled by the length of the world's railways or control them; but by working out the ϕ curves of these two quantities and moving the latter forward two years a coefficient of 0·82 is produced which Prof. Enström considers as "indicating a very high degree of correlation."

The working out of possible periods exercises great fascination on many minds, and trustworthy information regarding them is of decided value to science. But Beveridge's complete working out of the periodogram of wheat prices in western Europe led him to the conclusion that prophesying was not possible on the facts as he gave them; and Brunt's equally thorough investigation of Greenwich temperature led to a similar conclusion. Disappointment seems inevitable unless great care is exercised before domination by periods is announced, and we hope that the insight and industry of Prof. Enström will find further scope in their elucidation.

The Royal Observatory, Greenwich.

ANNUAL VISITATION.

THERE was a departure this year from the usual routine on the occasion of the annual visitation of the Royal Observatory, Greenwich, on June 6; for the Board of Visitors met at Dorking and inspected the new magnetic station at Abinger, which has been completed during the year.

A large number of invited guests were, however, present at the Royal Observatory and inspected the instruments. The report of the Astronomer Royal was presented, dealing with the twelve months ended on May 10, 1925.

Fundamental observations have been continued as usual; the mean error of Brown's longitude of the moon in 1924 is $-7\cdot10''$, practically identical with $-7\cdot12''$ in 1923. The altazimuth is being used for observation of fundamental stars in the prime vertical; the results are in close agreement with those of the transit circle, indicating a mean correction of $+0\cdot25''$ to Boss's Declinations between 12° and 50° N. The usual observations of variation of latitude were made with the Cookson floating zenith telescope. Application has been made to Cambridge Observatory for the renewal of the loan of this instrument for another seven years.

The 28-inch equatorial has been used for the measurement of 436 double stars, of which 37 were under $0\cdot5''$ separation. Dr. Steavenson observed Mars with this instrument last autumn; his drawings will be reproduced in the 1924 volume. 266 stellar parallaxes have now been determined with the Thompson 26-inch equatorial; details of all of them are ready for publication.

The 30-inch reflector is being used for the determination of stellar temperatures, using a prism crossed by a grating. Comparison is made with the positive crater of a carbon arc, which is mounted on the roof of the Octagon Room. The plates are measured in the micro-photometer; the results are stated to be encouraging. Four comets and two minor planets (including that of Baade) have also been observed both visually and photographically. New plates are being taken with the astrographic equatorial for the determination of proper motions in the Greenwich Zone (Decl. 64° to 90°). Between Decl. 64° and 66° there are 54 proper motions greater than 20″ a century (of which 29 are new), and 231 between 10″ and 20″; there are 18,194 stars in the zone.

There has been a considerable increase in sunspot activity; a spot in lat. 16° N. (on central meridian on May 6) was visible to the naked eye. Three papers dealing with the movements of spots and faculæ in longitude and latitude, and the rotation period given by long-lived spots, have appeared in the Monthly Notices of the Royal Astronomical Society.

Magnetic observations are being taken in duplicate at Greenwich and Abinger to establish the relation between them. The values (at Greenwich) of Declension W., Horizontal Force, Vertical Force, and Dip for 1924 are 13° 22·8′, 0·18426, 0·43115, and 66° 51·7′; the annual diminutions are 11·5′, 0·00007, 0·00033, and 0·5′ respectively. The West Declension at Abinger is about 12′ greater than that at Greenwich; but this needs further investigation, as a defect was found in the Abinger instrument which has only recently been corrected.

The new standard sidereal clock, by Mr. W. H. Shortt, has been in use since January 1, and is very satisfactory; the master pendulum is in a vault under the Octagon Room, and the slave clock in the ordinary clock room.

Wireless time signals are received daily from Paris, Bordeaux, Annapolis, and Nauen. The first three are in the mean late on Greenwich by 0·07 sec.; Nauen is late by 0·02 sec.

The Astronomer Royal refers in his report to the astronomers who have visited the Observatory during the year. Prof. Lundmark and Mr. Asklöf stayed for two months, studying photographic and parallax work; Mr. G. Merton is making a prolonged stay, being engaged chiefly in researches on cometary orbits. Several others paid short visits.

University and Educational Intelligence.

BIRMINGHAM.—Dr. W. N. Haworth, professor of organic chemistry in the University of Durham (Armstrong College, Newcastle-on-Tyne), has been appointed professor of chemistry, and director of the department of chemistry.

CAMBRIDGE.—Prof. A. C. Seward, Master of Downing College, has been re-elected Vice-Chancellor for the academic year 1925–6. Mr. H. Banister, St. John's College, has been appointed demonstrator in experimental psychology.

In connexion with the forthcoming meeting of the International Astronomical Union at Cambridge, it is proposed to confer the honorary degree of Doctor of Science upon the president of the Union, President W. W. Campbell, of the University of California; also upon Prof. W. De Sitter, of the University of Leyden; Prof. B. Baillaud, Director of the Observatory of Paris; Prof. H. Nagaoka, of the Imperial University, Tokyo; and Prof. F. Schlesinger, Director of Yale University Observatory.

At Trinity College the following appointments for 1925–6 have been made: Mr. Bertrand Russell to be Tarner lecturer in the philosophy of the sciences, and Major-General Sir Frederick Maurice to be Lees Knowles lecturer in military science.

The Statutory Commissioners have notified the University that they propose to modify the recommendation of the Royal Commission with regard to the proposed House of Residents as follows: that if a Grace passed by this house involves a change of either statute or ordinance of the University, an appeal may be made to the Senate under certain conditions. If in the vote in the Senate—the body of graduate voters including residents and non-residents—there is a majority against the Grace, the Senate's vote shall stand good (and the Grace shall be rejected), if in this second vote the majority against the Grace is larger proportionately to all the votes cast than the majority of residents' votes cast on the second occasion is to the total vote cast by the residents. How this ingenious scheme, which restores the ultimate authority over statutes and ordinances to the whole Senate, will work out in practice, remains to be seen. It may be hoped that it will not often be brought into use.

Preliminary steps in the organisation of the proposed scheme of faculties are indicated by the Commissioners in a second memorandum on the subject of initial appointments under the scheme and the position of the present staffs of University and College lecturers. It is contemplated that the new scheme will come into force on October 1, 1926.

OXFORD.—On Tuesday, June 2, Convocation passed a decree conveying the thanks of the University to Dr. F. D. Drewitt, Christ Church, for his gift to the Hope Department of six volumes of the original water-colour drawings of lepidoptera made by William Jones of Chelsea, and known as "Jones' Icones." Jones' drawings and descriptions are of high value to students of systematic entomology.

Under the auspices of the Vice-Chancellor, preparations have already begun for the visit of the British Association to Oxford in 1926. Local secretaries have been nominated, and a meeting has been summoned for the purpose of appointing a local general committee.

Dr. Harold A. Wilson, F.R.S., professor of natural philosophy in the University of Glasgow, has accepted reappointment to the professorship of physics which he held at the Rice Institute, Houston, Texas, from 1912 to 1924 inclusive.

Research in secondary education in America has been enormously stimulated since the War by the stream of pamphlets, leaflets, and magazines issuing from the Bureau of Education. At a conference of representatives of the National Society of College Teachers of Education and other interested bodies last March, a programme of co-operation was discussed and steps were taken towards the constitution of a National Committee to initiate, direct, and co-ordinate research. The Bureau of Education will act as a clearing-house for information on the subject.

The progress of educational research in the United States was extensively reviewed in the course of the proceedings of the education section of the American Association for the Advancement of Science at Washington last Christmas. A brief account is published in the February number of *School Life* of the scope of the papers—some forty or more—which were read on that occasion. The Americans are great experimenters, particularly in the very progressive private schools, in which the psychologist has a position and influence undreamed of in Great Britain. Among the more important of the large-scale experiments mentioned in the papers referred to is a progressive plan of grouping children by intelligence ratings that has been carried on in Detroit since 1920. In each of nine grades the children are divided into upper, middle, and lower groups, the upper and lower being each 20 per cent. of the whole. Basic courses of study and standards of promotion are worked out for each group, and special teaching methods are applied to the upper and lower groups. The scheme is reported to have worked well.

A statistical survey of education, 1921–22, being advance sheets from the biennial survey, 1920–1922, has been issued by the United States Bureau of Education as Bulletin, 1924, No. 38. It gives a total school and college enrolment of 26 millions, with an estimated cost of 2000 million dollars. Enrolments in institutions under private management were as follows: kindergartens, 10 per cent. of the total; elementary, 6 per cent.; secondary, 9 per cent.; normal schools and teachers' colleges, 6 per cent.; universities, colleges, and professional schools, 60 per cent.; institutions of all kinds, 8 per cent. The estimated cost of the elementary schools is 1240 million dollars, of high schools 450 millions, and of universities and colleges 273 millions. The per capita costs of elementary and high school education were the same in private as in public schools, but the per capita cost of university education was 581 dollars in public and 364 dollars in private institutions. It is interesting to compare with these estimates the per capita cost of education in the universities and university colleges of Great Britain (excluding Oxford and Cambridge) according to the tables recently issued for 1923–24 by the University Grants Committee. Including part-time (14,245) and full-time (33,752) students, the cost per student is 74*l*. or, at the current rate of exchange, 354 dollars—almost exactly the same as in private universities in the United States.

Early Science at Oxford.

June 15, 1686. A letter from our President dated April ye 10th. was read; it gave an account that one Mrs. Hoden had several times before the death of divers of her relations *dreamed* of the losse of two or more of her teeth, having had noe such dreams at other times.

Then was read an observation communicated by Dr. Benbrig, concerning a gentleman who had a violent *paine* in his *ear* caused by maggots in it, a fly haveing blown in it the day before: Some milk being poured into his ear, at least sixty maggots came out, and the pain ceased.

Dr. Edward Tyson, Dr. Tankred Robinson, Francis Aston Esqr, Mr. John Flamstead, Mr. St. George Ash of Dublin, and Mr. Christopher Pit of Wadham Coll. were elected members of the Philosophical Society.

June 16, 1685. A discourse of Dr. Robinson's, and a Letter of Mr. Ray's, both concerning the French Marneuse, were read.

Mr. Pulleyn brought in an abstract of ye way of making artificiall Amber, extracted from a MS in Magdalen Hall Library, it is as followes—

To make artificiall Amber.

Seeth Turpentine in an earthen pan well leaded, and put therein a little cotton, stirring it, untill it be as thick as paste, then pour it into what you will, and set it in the sun eight daies together, and it will be clear, and hard enough; you may make of this beads, hafts of knives &c: And when they are made so, set them to harden again in ye sun, and they will be very hard and clear.

A letter from Mr. Leigh giving a description and containing a draught of the Sepia, together with a paper written with ye naturall ink of that fish, was communicated. These things are sent up to ye Royal Society.

An accurate account with figures of a monstrous Cat dissected by Dr. Mullen of Dublin was comunicated in a letter from Mr. Ash, Secretary of ye Dublin Society, for which ye Society ordered their thankes to both these gentlemen.

A description and draught of an artificiall Fountain by Dr. Papin, was presented from Mr. Aston.

June 17, 1684. A letter from Mr. Aston, dated from London June ye 12th was read; a letter from Mr. Tancred Robinson, to Dr. M. L., concerning ye Bridg at Pont Esprit in France, was read. Dr. Plott affirms, that ye Bridg at Burton in Staffordshire (which is one of ye greatest in all England) is built after ye same manner with that at Pont St. Esprit: this occasion'd some discourse concerning ye running of Rivers; It was affirmed that Medway runns ye least way of any river in England, of that bigness.

Two remarkable cases relating to vision were communicated by Dr. Plot, to whom they were sent by Dr. Briggs of London; one of these cases was a *Nyctalopia*; a distemper not frequent amongst us.

It was affirmed, that Dr. Turberfeild of Salisbury has (not long since) met with a disease of ye eye as yet undiscovered, it was a bag of matter on ye outside of ye ball of ye eye, prominent from ye *tunica adnata*; the Dr. cured his patient, and called this distemper *Bursa Oculi*.

There being some Discourse concerning severall ways of makeing a *Spiritus fumans cum Aere*; it was ordered that a Spirit of that kind should be made, and an account of ye process brought into ye Society, which Mr. Bainbrigg undertook to do.

Dr. Pudsey, Fellow of Magdalen College, and Mr. Alexander Cuningham of St. Leonard's College in St. Andrews, were proposed to ye Society.

Societies and Academies.

LONDON.

Geological Society, April 22.—W. L. F. **Nuttall**: The stratigraphy and palæontology of the Laki series (Lower Eocene) of parts of Sind and Baluchistan (India). Some of the massive white foraminiferal Eocene limestones of Sind, with a thickness of about 600 feet, found along the Laki Range and in Lower Sind, contain a different and earlier fauna of Foraminifera than that of the Kirthar series as exposed in the Kirthar Range. In the area near Meting the following divisions in the Laki series are proposed: Laki Limestone, Meting Shales, Meting Limestone, Basal Laki Laterite. The term Alveolina Limestone is discarded, as Alveolinæ are found in both the Laki and the Meting Limestones. The Meting Limestone is correlated with the Dunghan Limestone of R. D. Oldham, which is found in the Bolan Pass and other places in Baluchistan. The Ghazij Shales of Baluchistan, which are absent in Sind, pass up conformably into the Lower Kirthar series. The upper part of these shales is younger than the Laki Limestone. In Sind the Laki Limestone is overlain unconformably by the Middle Kirthar, Nari (Oligocene), or Lower Manchar (Pliocene) beds. The Laki series rests unconformably on the Upper Ranikot, with the upper members of the Laki series as traced northwards overlapping the lower. The fauna of the Laki series, which is different from that of the Kirthar series, suggests that the former are of Lower Eocene age rather than Lower Lutetian, as has hitherto been supposed.

Linnean Society, May 7.—H. G. **Cannon**: The ectodermal origin of muscles in the crustacean, Chirocephalus. In the trunk region of a metanauplius of Chirocephalus the limbs appear at first as pouch-like outgrowths, the ectoderms between them forming a series of ridges projecting into the body-cavity. The inner edges of the ridges become nipped off from the more lateral ectoderm forming a string of cells containing deeply-staining fibrils. Later, dorsally and at the level of the inner face of the surrounding ectoderm cells, the fibrils lose their staining capacity and are replaced by a tendinous plate. Below this plate the fibrils divide into segments, converting the strings of cells into typical striped muscles. These muscles do not appear to correspond to the larval mesoderm of annelids.—Miss I. **Andersson**: The genetics of variegation and leaf-structure in ferns. Spores being sown on Knop-agar, the several kinds of prothallia could be counted and observed continuously. Segregation in respect of green or pale plastids may occur (1) at reduction, (2) during the prothallial growth, or (3) in somatic tissue of the sporophytes, or in any of these stages successively.—S. L. **Moore**: New species of Compositæ from Angola Land.

DUBLIN.

Royal Dublin Society, April 28.—H. H. **Poole**: The photo-electric measurement of submarine illumination. A method is described of using photo-electric cells for submarine photometry which may be employed in a comparatively small vessel at sea in fine weather. The photo-electric current is passed through a known high resistance, the P.D. between the ends of the latter being balanced against a potentiometer. A telephone is used as a detector instead of a galvanometer, thus rendering a steady support unnecessary. This is effected by including a special form of interrupter in the detector circuit of the potentiometer. This circuit also includes the primary of a two-valve amplifier, the output terminals of which are connected to the telephones. A vacuum photo-electric cell is used as a standard, the submarine illumination being measured by a cell of the Kunz type. The effects of obliquity of illumination and of reflection losses at the photometer window are specially considered. Preliminary tests have given satisfactory results.

Royal Irish Academy, May 11.—Miss A. L. **Massy**: An account of the Brachiopoda taken by the fishery cruiser *Helga* off the Irish coast, with a summary of previous Irish records. Eleven species are recorded, two from depths of more than 1000 fathoms, seven between 70 and 700 fathoms, and two from shallow water.

EDINBURGH.

Royal Society, May 11.—F. A. E. **Crew**: Unilateral vasoligation on the senile male of the domestic fowl. Unilateral vasoligation in the fowl is not followed by rejuvenation phenomena. This suggests that the gonad of the bird is not endocrinologically equivalent to that of the mammal.—Miss Sheina M. **Marshall**: Plankton of the Firth of Clyde. Notes of the species occurring and their seasonal distribution.—Miss Frances M. **Ballantyne**: The continuity of the vertebral nervous system: Studies on *Lepidosiren paradoxa*. Numerous stages in the development of sensory nerve trunks (olfactory, auditory, spinal, lateral line), demonstrate that each trunk develops out of a protoplasmic bridge joining end organ and central nervous system at an early period of development while they are still in close proximity. The relations between neurofibrils and ganglion cells was dealt with and evidence adduced in support of the view that there is no real discontinuity at the so-called synapse.—E. B. **Bailey**: Perthshire tectonics: Loch Tummel, Blair Atholl, and Glen Shee. The stratigraphical sequence of the district shows only minor variations from that worked out by E. M. Anderson at Schiehallion, farther west (Quart. Journ. Geol. Soc., 1923). One of the main stratigraphical divisions, the Perthshire Quartzite Series, is disposed in three distinct recumbent fold-limbs of great cross-strike extent. Of these, the Cairnwell Limb is top, the Tummel Limb is middle, and the Ben y Cloe Limb is bottom. Important slides have been developed, more particularly in connexion with the Tummel Limb. Subsequent recumbent folding has greatly affected the Tummel Limb and digitations of the Cairnwell Limb.

PARIS.

Academy of Sciences, May 4.—The president announced the death of M. Albin Haller.—E. **Goursat**: Some partial differential equations of the theory of deformation of surfaces.—G. **Bigourdan**: The equations, of various origins, which may affect the pendulum corrections employed at the Bureau International de l'Heure (B.I.H.) during the five years 1920–1925. The corrections are affected by various errors due to different causes; five years' observations are discussed and an attempt is made to separate some of these causes of error.—Nicolas **Kryloff**: The estimation of the error made in the application of the method of W. Rirz for the approximate integration of differential equations.—N. **Lusin**: A problem of M. Émile Borel and the projective ensembles of M. Henri Lebesgue; analytical ensembles.—V. **Romanovsky**: The distribution of the mean square errors in observations on quantities with normal distribution.—R. Dugas: The theory of fine structure and the principle of the equality of action and reaction.—L. Escande and M. Ricaud: The similitude of viscous fluids. Comparative experiments made with water and three oils of different viscosity. Reynolds's law held exactly, and the simultaneous application of the law of Reynolds and that of Reech showed that, giving to the homologous dimensions of two models a ratio equal to the ratio of the kinematic viscosity coefficients raised to the power 2/3, similitude was realised.—Henri Abraham and René Planiol: Magnetic sesquioxide of iron. Ordinary ferric oxide (colcothar) is not ferromagnetic. If a non-magnetic ferric oxide is reduced at 500° C. in hydrogen or in carbon monoxide, the reaction stops at about the stage of magnetite. This finely divided magnetite is not pyrophoric but is readily oxidised. If heated in air it burns like tinder and gives a non-magnetic red oxide; but if heated in a current of air at 200-250° C., oxidation is produced slowly and without incandescence. The resulting oxide is brown, has the same chemical composition as ordinary red ferric oxide, but is strongly ferromagnetic. Heated to 700° C. it is transformed into the non-magnetic red oxide.—Jean Jacques Trillat: Study of the fatty acids and the dicarboxylic acids by means of the X-rays. A slight alteration in technique, namely, dissolving the acid in alcohol, pouring some drops of the solution on a glass plate and allowing to evaporate, gives better results than the original method of pouring the melted acid on the plate. The thin layer behaves as a single crystal, and the X-ray spectrum shows only the fine lines corresponding to the length of the chain. Data are given for six fatty acids and four dibasic acids. The method can be applied in analysis, and will distinguish between a C_{17} acid and a mixture of C_{16} and C_{18} acids.—Salomon Rosenblum: A new determination of the ratio of the velocities of the two groups of α rays emitted by the active deposit of thorium. The ratio of the velocities of the α rays of thorium (C and C^1) is found to be 1·209, with a possible error of 0·1 per cent.—Th. De Donder: Affinity.—A. Boutaric and Mlle. G. Perreau: The quantitative study of the protection realised in a colloidal solution by the introduction of an electrolyte in a quantity too small to produce flocculation. Studies of colloidal suspensions of gamboge and sulphide of arsenic. The results are given in the form of curves.—Léon Guillet: The thermal treatment of certain nickel brasses.—Fred Vlès and Mlle. Madeleine Gex: The ultra-violet absorption as a function of P_H of some organic acids considered as ultra-violet indicators.—E. E. Blaise and Mlle. M. Montagne: The preparation of the acyclic δ-di ketones. By the condensation of ethyl magnesium bromide with the tetrethyldiamide of glutaric acid, the δ-diketone dipropionylpropane has been shown in an earlier communication to be one of the reaction products. It is now shown that the diethylamide of γ-propionylbutyric acid and a ketone of the constitution $C_2H_5 . CO . (CH_2)_3 . C(C_2H_5)_2 . N(C_2H_5)_2$ are also produced in this reaction.— — Lespieau and Charles Prevost: The hexabromide of diacetylene. The addition of bromine to diacetylene gives a hexabromide identical with that obtained by Noyes from the gas obtained by treating slightly oxidised copper acetylide with acid. From the hexabromide the diacetylene is easily regenerated by the action of zinc powder and alcohol.—Marcel Sommelet: The synthetic preparation of the homologues of benzyl chloride. The synthesis is based on the interaction of monochlormethyl ether and an aromatic hydrocarbon in the presence of stannic chloride as condensing agent.—R. Lantz and A. Wahl: The 1-arylamino-2-naphthoquinones.—L. Cayeux: The relative age of the silex and dolomites in the chalk of the Paris basin.—Louis Besson: The pluvial capacity of the equatorial current. The periodic factor of climate.—E. Demoussy: The changes in concentration brought about by diffusion.—St. Jonesco: The combined action of hydrochloric acid and metallic sodium on the reddening of a flavone extracted from the red leaves of *Prunus Pissardi*. The flavone, resembling quercitine in its behaviour to solvents, is attacked by metallic sodium, and the product of this reaction on treating with hydrochloric acid gives a red pigment. The latter does not appear to be a simple reduction product of the flavone, since other reducing agents do not produce the colouring matter.—Auguste Lumière and Henri Couturier: The ant-icoagulating action of zinc salts. Sulphate of zinc, in a concentration of 1 in 2000, completely prevents the coagulation of blood *in vitro*. Injection of the same salt into the living animal also has the effect of reducing the coagulability of the blood.—Mme. Randoin and E. Lelesz: Comparative variations of arterial glycæmia (effective and proteidic) and of the proportion of liver glycogen in the normal pigeon and in the pigeon submitted to a diet lacking in the water-soluble factor B. A deficiency of factor B does not prevent addition of the glycogen reserve nor does it prevent the sugar being set free in the blood, but the animal is deprived of a substance which is directly or indirectly indispensable to the combustion of the sugar.—P. H. Fischer: The rôle of the purple-producing gland of Murex and Purpura.—P. Cappe de Baillon: Double monsters in the phasmids.—L. Fage and R. Legendre: Swarms of *Scalibregma inflatum* observed while fishing with artificial light.

May 11.—Mlle. Madeleine Marquis, Pierre Urbain, and G. Urbain: The treatment of malacon. The separation of celtium from zirconium. Solution is effected by treatment with sulphuric acid followed by potassium bisulphate fusion; the zirconium and celtium are precipitated as double sulphate by addition of solid potassium sulphate. An account is given of various methods tried for the separation of these two elements. Fractional precipitation with saturated solutions of sodium carbonate has been found to give the best separation.—Gabriel Bertrand and M. Machebœuf: The presence of nickel and cobalt in animals. It has been shown that nickel and cobalt are widely distributed in arable earth and are also present in plants; nickel has now been proved to be present in animal tissues. In man and the higher animals the highest proportion of nickel is present in the liver. The amounts are extremely small, ranging from 0·004 milligram of nickel per kilogram of cow's milk to 0·455 milligram per kilogram in molluscs.—Paul Mentré: The projective properties of congruences, non W, with non-special complex linear osculator.—André Roussel: Semi-continuity and direct search for certain minima.—E. Henriot and E. Huguenard: The realisation of very high speeds of rotation. In the apparatus described the rotating body is not in contact with any liquid or solid and is free to take up its own axis of rotation. The rotor is supported and rotated by a current of compressed air; one model has maintained a constant velocity of 4000 turns per second for several hours.—P. Dumanois: The utilisation of anti-knocking compounds. A mixture of equal parts of petrol and kerosene with the addition of 1·5 parts per 1000 of lead tetraethyl gave good results in an internal combustion motor; there was no knocking, and the consumption was the same as when pure petrol was used.—R. **Forrer**: An artificial magnetic anisotropy of nickel. The attainment of a state with a particularly simple cycle.—Josef Mikulas **Mohr**: The pole effect of the barium and neodymium lines in the visible part of the spectrum. The differences in wave-length due to the pole effect were studied in the interference spectrograph of Perot, one light bundle being taken from one of the poles and the other from the centre of the arc. The differences of wave-length negative pole minus centre and positive pole minus centre are given in tabular form for the chief lines of barium and neodymium.—Mme. J. S. **Lattès**: A method of analysis by absorption of radioactive radiations. A general method is developed capable of being applied to the analysis of any radiation, however complex.—J. **d'Espine**: The magnetic spectrum of β rays of great velocity of radium-B + C. Measurements are given for 13 β rays of radium-B+C. The values of $H\rho$ are tabulated against the results of Ellis, Rutherford and Robinson, and Danysz, and are in good agreement with those of Ellis.—Louis Jacques **Simon**: Comparative chromic acid oxidation and molecular structure; tariric and stearolic derivatives.—Raymond **Delaby** and Georges **Morel**: The methylalkylglycerols. Notwithstanding the number of transformations involved, the best method of preparing the methylalkylglycerols is through the dibromhydrin, the stages being vinylalkylcarbinol, addition of bromine forming the dibromhydrin, conversion of the latter into the diacetin, from which the glycerol is obtained by the action of aqueous potassium carbonate.—Albert **Baldit**: Magnetic measurements in the centre and east of France.—Ernest **Esclangon**: Zones of silence by reflection on the surfaces of atmospheric discontinuities.—**Barré** and **Schnell**: The propagation of sound waves in the soil. Two velocities for sound in the soil were found: 2000 and 8500 metres per second. The higher velocity was found by observers on granite, the mine being also buried in contact with rock, whilst in experiments giving a velocity of 2000 metres the observer and the mine were both on sand.—René **Souèges**: The embryogeny of the Lythraceæ. The development of the embryo in *Lythrum Salicaria*.—C. **Charaux**: Datiscine, the glucoside of *Datisca cannabina*. Datiscine has the formula $C_{27}H_{30}O_{15}$, and crystallises with four molecules of water. Hydrolysed with acids, it gives equal molecules of datiscetine, glucose, and rhamnose, but on hydrolysis with a ferment it gives datiscetine and rutinose.—Marc **Bridel**: Primeverose, primeverosides, and primeverosidase. — Raymond **Hamet**: The medullary cribo-vascular formations of two Crassulaxeæ.—Lucien **Daniel**: New researches on heredity in the grafted Jerusalem artichoke.—A. **Maige**: Various methods of appreciation of the limiting level of amylogenous condensation.—A. Němec and K. **Kvapil**: The presence of nitrates in forest soils. Determinations of nitrate in soils of various ages under fir, pine, beech, oak, ash, and hornbeam.—F. **Couturier** and S. **Perraud**: Some properties of urea in contact with soils.—Adrien Auguet and Albert **Bruno**: The persistence of dicyandiamide nitrogen in a moulded calcium cyanamide, after remaining several months in the soil.—H. **Labbé** and B. **Théodoresco**: The action of insulin on the nitrogen metabolism. In a normal dog, injections of insulin are followed by an increase in the amounts of nitrogen excreted; the effect often persists several days after the injection.—Armand Dehorne; Observations on the biology of *Nereis diversicolor*.—**Goris** and M. **Metin**: The alteration of solutions of aconitine on keeping. On keeping aqueous solutions of aconitine nitrate there is a steady loss of toxicity; the decrease is very regular, and is proportional to the time.

CALCUTTA.

Asiatic Society of Bengal, April 1.—Hem Chandra **Das-Gupta**: On the occurrence of *Scylla Serrata* Forskal in the upper Tertiary beds of Hathab, Bhavanagar (Kathiawar). Fossilised specimens of the common edible crab of India have been known since 1767, but precise data regarding the locality and the age of the beds have been wanting. The sternal portion of such a fossil crab obtained from Hathab, Bhavanagar State, has been found in Miocene beds.—Kalipada **Biswas**: Sub-aerial Algæ of Berkuda Island. The Algæ occurred on the soil, on roofs, and on walls. Nine species are described, of which four are reported for the first time from India, and one—*Gomphospharia aponina*, var. *muralis-Biswas*—is a new variety.—D. **Majumder**: Some characteristics of Kolarian songs. The songs are classed under four groups: (1) General; (2) love-songs; (3) moral songs, addressed to boys or girls; (4) miscellaneous (domestic affairs, food, etc.).—D. **Majumder**: On the terminology of relationship of the Hos of Kolhan. There are mainly two systems of kinship terms. One is applied to groups, the other to individuals. The latter system is of rare occurrence.—Braja Lal **Mukherjee**: The word " vrā " in the Rig Veda. The word " vrā " means hunter, and does not mean troop or host.—J. J. **Modi**: A note on the custom of the interchange of dress between males and females.

VIENNA.

Academy of Sciences, March 12.—A. F. **Sonnenschein**: The homing of feelerless bees; a contribution to the sense of orientation in the honey-bee. Bees whose antennæ have been amputated find their hive and its entrance in much the same way as normal bees; the sense of smell does not seem essential for their return home.—M. **Kohn** and S. **Grün**: Bromo- and bromo-nitro-ether of pyrogallol (xii.). Communication on bromo-phenols.—M. **Kohn** and M. **Heller**: On the interchangeability of halogen atoms and of nitro groups in some nitro-halogen-phenol-ethers (xiii.). Communication on bromo-phenols.—M. **Kohn** and A. **Rosenfeld**: (1) New observations on halogen phenols (xiv.). Communication on bromo-phenols. (2) A contribution to the knowledge of the pseudo-phenols (xv.). Communication on bromo-phenols.—J. **Weissenberger**, F. **Schuster**, and R. **Henke**: On the molecular compounds of the phenols, the localisation of the field of force of the residual valency. On organic molecular compounds, the group CCl_3.

March 19.—R. **Schumann**: A contribution to the subterranean tectonic of the Vienna basin.—E. **Heinricher**: Cattle-grazing, a factor contributing to change of form and formation of species in plants. *Centaurea jacea*, var. *pygmæa*, an example.—K. **Horovitz** and J. **Zimmermann**: Investigations on the exchange of ions in glasses.—J. **Zimmermann** and J. **Schneider**: Characters of glasses in terms of their electromotive properties.—J. **Schaffer**: On extensible elastic sinews in skeletal muscles. The limits of elasticity are considered, also the case of a Paraguayan marsupial which hangs for hours by its tail from branches.—H. **Handel-Mazzetti**: New Chinese plants (xxxiii.).—The late G. von **Niessl**: Catalogue of data for determining the paths of 611 great meteors.—A. **Aigner**: The formation of valleys on the southern edge of the Lower Tauern.—A. **Friedrich** and J. **Diwald**: On the lignin of pine-wood.

Official Publications Received.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 20, Part 14: The American Species of Canavalia and Wenderothia. By C. V. Piper. Pp. viii+555-588. (Washington: Government Printing Office. 10 cents.

Royal Botanic Gardens, Kew. Orchids (*Orchidaceæ*), Set 3. 6 post cards in colour with descriptive Folder. (Kew: Royal Botanic Gardens.) 1*s*.

Proceedings of the Royal Society of Edinburgh, Session 1924-1925. Vol. 45, Part 1, No. 11: The Modes of Vibration of a stretched Membrane with a particular Law of Density. By Dr. E. L. Ince. Pp. 102-116. 1*s*. 6*d*. Vol. 45, Part 1, No. 12: A Survey of Clyde Plankton. By Sheina M. Marshall. Pp. 117-141. 2*s*. Vol. 45, Part 1, No. 13: The Relation of Sea-Growth and Spawning Frequency in *Salmo salar*. By W. L. Calderwood. Pp. 142-148. 9*d*. Vol. 45, Part 1, No. 14: The Minimum System of Two Quadratic Forms in *n* Variables. By Prof. H. W. Turnbull and J. Williamson. Pp. 149-165. 1*s*. 6*d*. Vol. 45, Part 1, No. 15: The Law of Blackening of the Photographic Plate at Low Densities. By E. A. Baker. Pp. 166-186. 2*s*. Vol. 45, Part 1, No. 16: The Theory of Compound Determinants from 1900 to 1920. By Sir Thomas Muir. Pp. 187-212. 2*s*. 6*d*. Vol. 45, Part 2, No. 17: Discontinuities in the Atmosphere. By A. H. R. Goldie. Pp. 213-229+4 plates. 2*s*. 6*d*. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. Studies concerning the Pollination, Fertilization and Breeding of Red Clover. By R. D. Williams. (Series H, No. 4, Sessions 1921-24.) Pp. 58. (Aberystwyth.) 3*s*. 6*d*.

Transactions of the Royal Society of Edinburgh. Vol. 53, Part 3, No. 31: The Permian Fish *Dorypterus*. By E. Leonard Gill. Pp. 643-661. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 2*s*. 6*d*.

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1922-23. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment, and Harvest Prices in British India. Pp. ix+81+10 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s*. 4*d*.

Bulletin of the National Research Council. Vol. 10, Part 2, No. 52: Honors Courses in American Colleges and Universities. By Frank Aydelotte. Second edition, revised. Pp. 96. (Washington, D.C.: National Academy of Sciences.) 1 dollar.

Safety in Mines Research Board. Paper No. 7: Second Report of the Explosives in Mines Research Committee, 1924. Pp. 10. (London: H.M. Stationery Office.) 3*d*. net.

Medical Research Council. Fifth Annual Report of the Industrial Fatigue Research Board to 31st December 1924 (including Personal Contributions from Investigators). Pp. 76. (London: H.M. Stationery Office.) 1*s*. 9*d*. net.

Leeds University: Department of Pathology and Bacteriology. Annual Report. By Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 15. (Leeds.)

Bulletin of the American Museum of Natural History. Vol. 52, Art. 1: Scientific Results of the Expedition to the Gulf of California in charge of C. H. Townsend, by the U.S. Fisheries Steamship *Albatross* in 1911. 14: Deep Sea Fishes of the *Albatross* Lower California Expedition. By Charles H. Townsend and John T. Nichols. Pp. 20+4 plates. (New York.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 1: Månadsöversikt av väderlek och vattentillgång jämte anstaltens årsberättelse. Pp. 101. (Stockholm.) 2.50 kr.

Recueil des travaux chimiques des Pays-Bas. Publié par la Société Chimique Néerlandaise. Tome 44 (4e Série, T. 6), No. 5, Mai. Numéro jubilaire en l'honneur du Professeur Bohuslav Brauner, publié par ses amis et élèves en commémoration de son 70e anniversaire, 1855-8 Mai-1925. Pp. 281-628. (Amsterdam: S. A. d'Éditions scientifiques D. B. Centen.)

Aeronautical Research Committee. Reports and Memoranda, No. 949 (Ae. 169): The Performance of Tandem Systems. By H. Glauert. (A. 3. a. Aerofoils, general, 118—T. 1777.) Pp. 11+4 plates. 6*d*. net. Reports and Memoranda, No. 953 (Ae. 172): Experiments to verify the Independence of the Elements of an Airscrew Blade. By C. N. H. Lock, H. Bateman and H. C. H. Townsend. (A. 3. d. Airscrews 75—T. 1978.) Pp. 4+4 plates. 4*d*. net. (London: H.M. Stationery Office.)

Instituts scientifiques de Buitenzorg. "'s Lands Plantentuin." Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 6, livraison 2, février. Pp. 93-220. (Batavia.) 2.50 f.

Department of the Interior: United States Geological Survey. Bulletin 755: Mineral Resources of Alaska; Report on Progress of Investigations in 1922. By A. H. Brooks and others. Pp. ii+222+xv+12 plates. 40 cents. Bulletin 764: Phosphate Deposits in the Wind River Mountains, near Lander, Wyoming. By D. Dale Condit. Pp. v+39+3 plates. 15 cents. Bulletin 770: The Data of Geochemistry. By Frank Wigglesworth Clarke. Fifth edition. Pp. 841. 1 dollar. (Washington: Government Printing Office.)

Diary of Societies.

SATURDAY, JUNE 13.

MINING INSTITUTE OF SCOTLAND (at St. Margaret's Hall, Dunfermline), at 3.30.—General Meeting.

PHYSIOLOGICAL SOCIETY (at Manchester).

MONDAY, JUNE 15.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. Alfred T. Schofield: The Capture of the Unconscious (Annual Address).

ROYAL SOCIETY OF MEDICINE, at 9.30.—Dr. F. Buzzard: Charcot and the Centenary Celebration of his Birth.

TUESDAY, JUNE 16.

INSTITUTION OF MINING ENGINEERS (at South Wales Institute of Engineers, Cardiff), at 11 A.M.—Sir John Cadman: Petroleum Refining in South Wales.—Dr. J. S. Haldane: The Maximum Efficiency of Heat Engines and the Future of Coal and Steam as Motive Agents.—The Shutting Off of Gob-Fires in Gassy Seams (Memorandum by the Gob-Fires Committee of the Institution).—J. I. Graham and Dr. T. D. Jones: Spontaneous Combustion in the South Wales Coalfield.—J. H. Cockburn: The Principles and Operation of the Mines (Working Facilities and Support) Act, 1923, Part I.

ROYAL INSTITUTION OF GREAT BRITAIN (jointly with Chemical Society, Society of Chemical Industry, and Association of British Chemical Manufacturers) (at Royal Institution), at 11 A.M.—Celebration of the Discovery by Michael Faraday of Benzene.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (III.).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—G. F. Shirras: Taxable Capacity and the Burden of Taxation and Public Debt.

MINERALOGICAL SOCIETY (at Geological Society), at 5.30.—Dr. A. Hutchinson: (*a*) The Use of Alignment Charts in Crystal Optics; (*b*) The Use of the Stereographic Protractor for the Interpretation of Laue Crystal Photographs.—H. E. Buckley and W. S. Vernon: The Crystal-structures of the Sulphides of Mercury.—Dr. E. Spencer: Albite and other Authigenic Minerals in Limestone from Bengal.—Dr. R. Campbell and J. W. Lunn: Chlorophæite in the Dolerites (Tholeiites) of Dalmahoy and Kaimes Hill, Edinburgh.—Dr. L. J. Spencer: Tenth List of New Mineral Names; with an Index of Authors.

WEDNESDAY, JUNE 17.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 4.30.—Mrs. S. Stevenson: The Dheds.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles from December 1923 to November 1924.—D. N. Harrison and Dr. G. M. B. Dobson: Measurements of the Amount of Ozone in the Upper Atmosphere.—J. Baxendell: Meteorological Periodicities of the Order of a Few Years, and their Local Investigation; with Special Reference to the Term of 5·1 Years in Britain.

SOCIETY OF GLASS TECHNOLOGY (at Sheffield).

THURSDAY, JUNE 18.

ROYAL SOCIETY, at 4.30.—Lord Rayleigh: Luminous Vapour from the Mercury Arc and the Progressive Changes in its Spectrum.—Prof. J. C. McLennan and A. B. McLay: On the Series Spectrum of Gold.—Prof. W. A. Bone, D. M. Newitt, and D. T. A. Townend: Gaseous Combustion at High Pressures, Part V.—W. T. David: The Effect of Infra-Red Radiation upon the Rate of Combustion of Inflammable Gaseous Mixtures.—R. K. Schofield and Dr. E. K. Rideal: The Kinetic Theory of Surface Films.—*To be read in title only*:—Prof. H. M. Macdonald: The Condition that the Ratio of the Intensities of the Transmitted and Reflected Electric Waves at the Interface between two Media is independent of their Plane of Polarisation.—Prof. C. V. Raman and L. A. Ramdas: The Scattering of Light by Liquid Boundaries and its Relation to Surface-Tension. Parts I. and II.—H. Weiss: The Application of X-rays to the Study of Alloys.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Hon. W. G. A. Ormsby-Gore: Some African Problems.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. S. A. K. Wilson: Disorders of Motility and of Muscle Tone, with special reference to the Corpus Striatum (Croonian Lectures) (IV.).

CHEMICAL SOCIETY, at 8.—H. Phillips: Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXVII. Some Esters of *p*-toluene Sulphonic and Sulphinic Acids.—F. R. Goss and Dr. C. K. Ingold: The Enhanced Reactivity of Newly-formed Molecules. Part I. The Conversion of Cyclols into Ketones.—F. H. McDowall: Constituents of *Myoporum lactum* Forst ("The Ngaio"). Part I.—J. Kalff and R. Robinson: A Synthesis of Datiscetin.—J. Allan, A. E. Oxford, R. Robinson, and J. C. Smith: The Relative Directive Powers of Groups of the Forms RO- and RR'N- in Aromatic Substitutions. Part IV. A Discussion of the Observations recorded in Parts I., II., and III.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Annual General Meeting) (at 11 Chandos Street, W.1), at 8.15.—Induction of Dr. A. Balfour as President.—Dr. G. C. Low: The Use of a Drug named "Smalarina" in the Treatment of Malaria.—Award of the Chalmers Medal to Prof. Warrington Yorke, who will read a paper on Further Observations on Malaria made during Treatment of General Paralysis.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY.—Summer Meeting in the Gloucester District (continued on June 19, 20).

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.

FREE PUBLIC LECTURE.

THURSDAY, JUNE 18.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Dr. R. Robison: The Chemistry of the Calcification of Bone.