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THE LIFE OF LORD KELVIN.

The Life of William Thomson, Baron Kelvin of Largs. By Silvanus P. Thompson. Vol. i., pp. xx+584; vol. ii., pp. xi+585–1297. (London: Macmillan and Co., Ltd., 1910.) Two vols. Price 30s. net.

THE task of the biographer is, in several respects, a very different one from that of the scientific historian. Indeed, it may be affirmed with some shadow of truth that the best biography belongs to the domain of imaginative literature. For to be perfectly successful the biographer must make a hero of his subject; in other words, he must, as an artist, idealise without destroying the features he endeavours to portray. Too often he is a mere ordinary photographer who removes wrinkles and smooths over defects, and thereby produces a picture, recognisable indeed, but of a man in unnatural pose, and ill at ease in holiday garments. Again, the true artist does not crowd his canvas too much, nor does he labour the details of his picture too diligently; we are not tempted to look through our magnifying glasses at particular parts of it, to our loss of the effect of the whole. Finally, he must write from personal knowledge, and with the warmth of personal affection; but he must not allow his feelings to outrun his discretion, or permit his devotion to blind him to the fact that his hero shared the limitations of ordinary humanity. It is just to say that Prof. Thompson passes these tests with a fair measure of success. His biography is well and sympathetically written, it affords a vivid, and, on the whole, a true picture of Lord Kelvin as a student of science, as a university teacher, as an engineer and man of affairs, and as the colleague and friend of a large circle of those devoted to science. If here and there—for example in the account of the latter part of Lord Kelvin's student career and of the proceedings at the Kelvin jubilee—the detail is worked with too microscopic minuteness, the lines are generally bold enough to show the man and his work in fair proportion, and to leave the reader with a feeling of contentment with the manner in which the story of a great life has been told and its achievements recounted.

The task of the scientific historian has already been attempted by Larmor, who has framed an estimate of Lord Kelvin's work such as hardly anyone else could have composed at the present time. But that work will not be seen in its true perspective until some interval of time has elapsed; its full effect on the progress of science cannot until then be traced in detail in the complicated web of scientific fact and theory which so many artists have woven, each interpreting the part of nature's design which lay before his eyes.

The sketch of Prof. James Thomson, Lord Kelvin's father, and of college life in Belfast and Glasgow in the second, third, and fourth decades of the nineteenth century, is somewhat more meagre than it might have been, perhaps; and a little later, when the professor of mathematics appears again, the picture seems a little out of focus. Tales of his efficiency, and of the respect and admiration with which his students regarded him as a teacher, are still current among the few Glasgow graduates who remember the old college as it was in those days, at the beginning of the last quarter of a century of its existence. But no doubt many of the readers of Prof. Thompson's book, like the present writer, have come to it fresh from the perusal of the charming account of the family life of the Thomsons contained in Miss Agnes King's recently published "Lord Kelvin's Early Home"—the reminiscences of Mrs. King, Lord Kelvin's eldest sister—a narrative which, Prof. Thompson tells us, he has purposely refrained from trenching upon.

Prof. James Thomson's oral examinations are still spoken of as stimulating and instructive, and his example was followed with success in Aberdeen by David Thomson, who went there to be professor of natural philosophy after teaching Dr. Meikleham's classes during the years that preceded William Thomson's return from Cambridge. But the power of effective oral examination, like that of maintaining order without effort, is the result of a certain almost indefinable personal quality which many highly gifted men do not possess. The advent of Dr. James Thomson put an end at once to the pea-shooting and other antics in which the students of mathematics had previously indulged; and his personality impressed itself in other ways on university discipline and the conduct of university affairs, through his influence as a member of the Faculty, which, not the Senatus, was then the administrative governing body. In later days the respect which the students felt for William Thomson's scientific eminence, and the controlling force of his temperament, combined to preserve order in his presence and prevent the most daring from taking liberties. His oral examinations, however, were rather an occasion for digressions, which, though highly interesting and instructive in themselves, were not always such as to recall and elucidate the topics dealt with in the previous lecture.

The old college, Prof. Thompson says, was surrounded with horrible slums, and no doubt its environment was sufficiently wretched. This should not be misunderstood. Things were not always so bad in that part of the city, and at the present time, thanks to the Glasgow City Improvement Trust, the conditions of life in the east end have been greatly improved. In the 'thirties and 'forties, when the Thomsons lived in the residential court of the college, the old order of things was passing away. Bailie Nicol Jarvie no longer lived over his counting-house, and the tobacco lords and other wealthy merchants, grown distrustful of the comforts of the Saltmarket, were migrating from Virginia Street to comfortable villas and self-contained houses in the west end, where in a freer air and more healthful surroundings they lived a not much less frugal life. The birth and development of engineering established factories on the Clyde, and brought labourers and mechanics from all quarters. The lanes of the east end were transformed, from places not very different from those which abut against some of the colleges of Oxford and Cambridge, to rookeries of the worst description. The University had either to await the amelioration of these surroundings, which came later, or leave its beautiful old quadrangles to seek a new home where no such environment existed. Since its establishment on Gilmorehill, it has found the growth of engineering science react enormously on the study of natural philosophy; and now a great new Natural Philosophy Institute and the James Watt Engineering Laboratories exist together, within hearing of the clang of hammers in the great practical laboratories of the Clyde, with which, by their students and the practical problems which continually arise for solution, they are kept constantly in touch. The opening of this institute and of other new buildings by the Prince of Wales on April 23, 1907, was the last public ceremony at which Lord Kelvin presided as Chancellor of the University. The conferring of honorary degrees on the Prince and Princess, which was only one of the incidents of the ceremony, is mentioned by Prof. Thompson; but the real occasion of the visit, directly connected though it was with Lord Kelvin's own work in the University, has somehow escaped his attention.

A full account is given of Lord Kelvin's undergraduate career at Cambridge, and of the visit to Paris which followed it. By that visit, which he made at the suggestion of his father, and with introductions obtained by him, the young mathematician benefited in many ways. He made the acquaintance of Cauchy, Chasles, Liouville, Sturm, and Regnault, and besides studying French—and the cornopean—under Parisian teachers, devoted himself to practical physical work under Regnault, who was perhaps the greatest experimentalist of the century. He received no systematic instruction in experimenting—there was then no provision for such instruction, nor for long after was any provided at any university—but he was present to work the air-pump or to hold a tube, or to stir a calorimeter when told to do so, and thus learned something of the technique of physical manipulation. It must be admitted that he never became himself an expert at such work; and his natural impetuosity in later years, when the irons he kept in the fire were almost innumerable, made his presence in the laboratory a source of perturbations which seriously interfered with the systematic progress of research. Thus there was just a shade of truth in the legend—written on the blackboard by a laboratory student when the knighthood after the laying of the 1866 Atlantic cable was announced—"The (k)night cometh when no man can work"!

The story of his election to the chair of natural philosophy in 1846 is told in detail, and it is interesting to read the principal testimonials presented by Thomson, which have been printed from a complete set in the possession of Dr. Hutchison, of Glasgow. There can be no doubt that he had already impressed all the scientific men whom he had met with his extraordinary ability and promise, and all who support his candidature—including MM. Regnault and Liouville, and Hopkins, Fuller, Leslie Ellis, and De Morgan, predict for him a distinguished future as an investigator. In an appendix to chapter v. (the subject of which is "The Young Professor") is printed the famous introductory address which was annually brought out to be read at the first meeting of the natural philosophy class for the session, but which was invariably departed from within the first three or four minutes, and laid aside to be taken up again only after the lapse of another year. It was a matter for regret that it was not read through each year—it *was* read through in 1846, in much less than the allotted time, and Thomson was so disconcerted that he could find nothing to go on with!—for its language is simple and yet dignified, and well fitted to impress the minds of youthful students beginning the study of natural science. In this address he distinguishes between what he calls "mental history" and "mental philosophy," and between "natural history" and "natural philosophy." He says that

"What may by the analogy of terms be called *mental history*, that is to say, a combination of personal experience and a knowledge of men and of manners, with the study of politics and history, leads us to reason upon the abstract properties of mind, and to investigate that system of general laws on which *mental philosophy* is founded. So in the study of external nature, the first stage is the description and classification of facts observed with reference to the various kinds of matter of which the properties are to be investigated; and this is the legitimate work of *Natural History*. The establishment of general laws in any province of the material world, by induction from the facts collected in natural history, may with like propriety be called *Natural Philosophy*."

Thus the observations, and their comparison and classification, which led to Kepler's laws, belong to the "natural history" of celestial mechanics; Newton's deductions from Kepler's laws, and the theory of universal gravitation, which account for all the motions of the planets, belong to the "natural philosophy" of the subject. The fundamental subject of natural philosophy is said to be dynamics, or the science of force, and it is interesting to find the importance of this foundation insisted upon for all the principal divisions of physics. Referring to three of these—heat, electricity and magnetism, he says:—

"Our knowledge of these branches of the science is not so far advanced as to enable us to reduce all the various phenomena to a few simple laws from which, as in mechanics, by means of mathematical reasoning, every particular result may be obtained; but observation and experiment are the principal means by which our knowledge in this department may be enlarged. Hence what is called the experimental or physical course includes these three subjects; while the more perfect sciences of mechanics [here he means "dynamics"; "mechanics" he always defined as the science of machines] and optics, being really mathematical subjects, form a distinct division of the studies prescribed by the University for the complete course of Natural Philosophy."

Thomson does not seem to have dwelt on the deductive processes of mathematical physics in his address, though these are quite as important as the induction with which they must be combined. The deductive process by which Adams and Leverrier made out the place of the planet Neptune from the perturbations of Uranus gave a result which, when found to agree with observation, was generally regarded as affording a much more forcible proof of the truth of the gravitational theory than all the induction which preceded it, and the same thing may be said of results in other departments of physics, which illustrate the *predictive* value of a true theory. A reference to Adams and Leverrier, and the discovery of Neptune, was made in the address, but after 1862 it was omitted by the advice of Prof. Tait, who thought that the subject of Neptune had been "ridden to death."

The provinces of heat, electricity and magnetism, which are referred to in the introductory address as lying in great measure outside the scope of dynamics, it was Thomson's destiny to bring under the sway of the science of forces. He is already, when in Paris, meditating on the results set forth in Gauss's great memoir on attracting and repelling forces varying inversely as the square of the distance, and noticing how the general theorems there given lead to conclusions which were afterwards expressed in the language of the theory of energy. The letter (quoted on p. 130) is interesting in this connection and in some others.

"April 8, 1845. To-day, in the laboratory (of Physique at the Coll. de France, M. Regnault, Prof.), I got the idea which gives the mechanical effect necessary to produce any given amount of free electricity, on a conducting or non-conducting body. If m is any electrical element, v the potential of the whole system upon it, the mechanical effect necessary to produce the distribution is Σmv. . . . Also the theorem of Gauss that Σmv is a mimim. when v is const., shows how the double int[l] which occurs when we wish to express the action directly, may be transformed into the diff.-co. of a simple int[l] taken with reference to the distance between the two spheres. . . . This has confirmed my resolution to commence experimental researches, if ever I make any, with an investigation of the absolute force of statical electricity. As yet each experimenter has only compared intensities by the dev[ns] of their electrometer."

Here we have the train of ideas in progress which led, no doubt, to some of the series of papers on the mathematical theory of electricity which were published later in the *Cambridge and Dublin Mathematical Journal*. But what is still more particularly to be remarked is the determination to measure forces in absolute units. In the discussions of Lord Kelvin's work which have appeared in print, hardly sufficient importance has been attached to the part which Thomson played in the working-out of the scheme of absolute measurements the beginnings of which were made by W. Weber and Gauss. Perhaps, as he confessed later in one of his addresses, he never succeeded in getting the capacities of the leyden jars in his laboratory expressed exactly in absolute units, but it became possible to obtain a fair estimate of these capacities, and to measure, also in absolute units, by means of the beautiful electrometers which he afterwards made, the potentials to which the jars were charged, and therefore to say approximately, in ergs, how much energy was stored up in a particular jar when charged to the measured potential. Each experimenter, he says, expressed his results in terms of the deflections of his own electrometer: not merely was that the case, but currents were measured by each experimenter in divisions on his own galvanometer, and the insulation resistance of a cable at one time could only be compared with its value at another time by using the same instruments as before and reproducing exactly the former conditions. All this had to be swept away and an absolute system substituted when Atlantic cables began to be laid; but an enormous amount of exceedingly valuable work, both theoretical and experimental, had to be done ere a proper system could be elaborated. No small amount of this was accomplished by Thomson and his volunteer laboratory corps at Glasgow, in the "coal hole at the old college," as some members of that corps have since described the famous "first laboratory for students." Then the toil which the members of the British Association Committee undertook in working out, perfecting, and realising the system of units! It was work which did not attract public attention or strike the public fancy; and yet hardly anything else has done more to render possible practical applications of electricity in all their modern ramifications.

In the early 'fifties came the papers on the theory of heat. The account of Carnot's theory of the motive power of heat, with its determination of Carnot's function from Regnault's experiments on steam, valuable as it was, seems to have led Thomson's thoughts into a kind of groove, from which, when Joule's proof that heat and work were equivalent was published, he had some difficulty in escaping, and which involved him in considerable perplexity. It is, as Prof. Thompson says, entirely to the credit of Clausius that he saw clearly at once the full force of Joule's discovery, and accepted implicitly the first law of thermodynamics to which that discovery pointed. After that the necessary modification of Carnot's theory followed immediately, and Carnot's notion of a cycle of operations enabled the whole of the immediate consequences of the true dynamical theory to be worked out. A little later, but independently, Thomson also arrived at the true theory, and by an "axiom," or rather postulate, very differently expressed from that employed by Clausius, but on the whole equivalent, showed that the efficiency of all ideal thermodynamic engines, no matter what their working substances were composed of, had the same value. This in Thomson's hands led afterwards to his definition of absolute temperature, a conception which Prof. Tait used to insist, in the pages of NATURE and elsewhere, was of the most enormous importance, and ought to be set forth at the outset in every treatise on the subject.

Thomson's great paper, followed up as it was by developments and applications of the theory in his later writings, was destined to exert a profound influence on the study of thermodynamics both in this country and abroad. This result was in part due to the peculiarities of his treatment of the subject, which were characteristic of his practical genius.

The object of the memoir is first clearly announced, then the process and its results are unfolded, with a reference at every principal step to the physical meaning of the operation performed and the result obtained; and in every part the process adopted is preceded by a carefully worded statement of the assumptions made, and the presuppositions involved. Clausius, on the other hand, and with him almost every Continental writer, begins by referring to an undefined substance called a "perfect gas," and by means of that substance absolute temperature is defined as R/pv, where R is a constant and p and v are respectively the pressure and volume of a given mass of the gas. Thomson obtained his scale of temperature by means of an ideal engine; and then came the comparison of his scale with that of the air thermometer, by means of his porous plug experiment, which he carried out in collaboration with Joule, in the famous series of experiments on the thermal effects of fluids in motion. This experiment falls at once into clear relation to the whole theory in Thomson's sequence of ideas; this is hardly the case in the other mode of treating the subject.

The earlier papers on heat were all communicated to the Royal Society of Edinburgh, of which Thomson became a fellow in 1847. Of this society he was Keith medallist in 1864, and one of the chief grounds for the presentation of the medal was the discovery of the theorem of minimum energy of a system of connected particles, started by impulses applied at specified points and subject to the condition that the velocities of these points have specified values. This theorem is stated by Prof. Thompson on p. 1141, with rather less than sufficient caution; for if the condition be that the *impulses* applied at the specified points are also specified the motion is one of maximum energy. The far-reaching scope of this theorem is now much better understood than it used to be; for example, by analogy, certain theorems of electricity may be regarded as particular cases of it. The whole subject of these general dynamical theorems has been discussed by Lord Rayleigh in his "Theory of Sound."

The appointment of Tait to the chair of natural philosophy in Edinburgh led to the literary partnership which had as its result the publication in 1867 of the first volume of the "Treatise on Natural Philosophy," and in 1873 of the companion volume, "The Elements of Natural Philosophy." It is matter of keen regret that the second volume at least of the treatise was not forthcoming. For continually in his lectures in 1874, and for some years later, Thomson referred to the discussion of properties of matter which would be contained in that volume, and references to it are frequent in vol. i. If that chapter had been given to the world the treatises on electricity, sound, and hydrodynamics, which we owe to Maxwell, Lord Rayleigh, and Lamb, might well console us for the abandonment of the original scheme. But, as it is, all the old Glasgow students of natural philosophy, who have kept up the study of the subject, will ever regret the loss of the promised chapter, of which they obtained now and then glimpses, when Thomson referred, for example, to the difficulties of the elastic solid theory of the æther, and showed that similar difficulties arose when we attempted to explain the properties of cobblers' wax!

A good idea of Tait's breezy and energetic style of work will be obtained from the letters printed at p. 453, and elsewhere. He was a man of the most kindly feeling and disposition, though the native force of his character and intellect made him a formidable opponent and a severe critic and controversialist. His famous lecture on force will never be forgotten by those who heard it in the Kibble Palace, in Glasgow, in 1876; only a faint idea of it can be obtained by reading his "Recent Advances in Physical Science." He was orderly and methodical; his statements, whether oral or written, were brief and precise, and his lectures were commended by all his students for their unfailing experimental illustrations and the clearness of their expositions.

Thomson could also be clear and precise, nobody more so; but in his popular discourses he was always so preoccupied, and every thought so inevitably suggested new and interesting relations of things, that all his hearers, except a very few, quickly gave up the attempt to follow his lecture, and settled down to listen in admiration and amazement. The writer will never forget the discourse on "Isoperimetrical Problems" which Lord Kelvin delivered at the Royal Institution in May, 1893. The half-humorous picture of the wounded Horatius Cocles limping after the plough, and drawing his furrow so as to get the greatest possible area of land within the given length of boundary, brought the problem home to even the most unmathematical dweller in Mayfair who was present; but when the lecturer went on to make Horatius take account at every step of the quality of the soil, so as to place the maximum value of corn land within his boundary, wonder melted into sympathy for the crippled warrior confronted with such a terrible task! It is well known that the Friday evening discourses must begin at nine o'clock and terminate precisely at ten; but this law, which no one else dared to break, Lord Kelvin disregarded, for when ten o'clock came he had just got into his subject, and he went on—with apologies, of course—until nearly eleven! Such were his fire and enthusiasm; and to the few who remained to the end the *tour de force* was amazing. This would never have happened with Tait; the whole matter would have been thought out from beginning to end; all ideas that might have led him from his straight path would have been ruthlessly put aside, and a model of polished and clear exposition presented. As a rule, Thomson's sentences, both written and spoken, were too heavily loaded with saving clauses; as if he considered himself too absolutely committed to a conditional statement, if its limitations were not all given with it in one word-formula.

It is little wonder in some ways that the literary partnership broke down. But the book was, as Prof. Thompson has called it, emphatically an epoch-making one. It called for and brought about a return to Newton in dynamical method; and it pointed out how the neglected *scholium* on Newton's third law contained in substance the theory of energy. Other text-books are more popular; even the "Elements"—

consisting as it did in many places of the large-type statements of the treatise, without the small-type mathematical demonstrations—was too strong meat for the babes of the Glasgow class. The muttered groans of the students, when on Friday Thomson would first ask them to read twenty or thirty pages of the book before Monday, and then turn to McFarlane and tell him to see that questions were set on the part prescribed in the forthcoming Monday morning examination paper, never reached his ear, and with a bland smile, as if he had just prescribed a novel for the week-end, he used to turn to his oral examination and his lecture.

With regard to the somewhat strong remarks, which we find quoted on p. 445, as to the absurdity of causing Thomson to teach elementary physics, it is right to say that in 1846, when he sought and obtained the chair, the plain everyday duty of the professor of natural philosophy was to teach the natural philosophy class, and that, so far as Thomson was concerned, his time, energy, and original power were far from wasted in meeting from day to day his band of students, most of them eager to learn, and many of them willing to help in his researches. There is no doubt whatever that the attempt to teach them gave him inspiration, and from them came, as another important reward, his laboratory corps, who helped him so much. Witness the tribute to the divinity and other students in the Bangor address. Moreover, it does not seem to be generally known that from the early 'seventies onwards Thomson met the ordinary class only twice, and the higher class only once, a week. He would most certainly have been himself the strongest objector to any arrangement that would have cut him off altogether from his ordinary students. The reflection on the University is undeserved.

Prof. Thompson's second volume begins with 1871, in which year Thomson was president of the British Association at its meeting in Edinburgh. During the following fifteen years or so he was at the height of his activity. His Atlantic cable-laying expeditions were over in 1869, and he had purchased the *Lalla Rookh*, and begun the series of yachting excursions and hydromechanical and other experiments at sea which resulted in the compass and sounding machine. A year or two later some further cable-work was undertaken, which occasioned an eventful visit to Madeira; and then came the introduction into navigation of the fully corrected compass and the sounder, which are now in one form or another on board every well-found and properly equipped sea-going vessel. In the 'eighties he delivered the Baltimore lectures, and invented the various standard electrical instruments for exact laboratory and workship measurements. Afterwards, in the 'nineties, came the peerage, the presidency of the Royal Society, and the never-to-be-forgotten jubilee celebration in 1896.

Of Lord Kelvin's cable work, both theoretical and practical, extending from 1857 to 1874, and of his many other practical activities, Prof. Thompson's book contains an admirable account. It is written in such a way that anyone, however non-mathematical or non-physical, can read it with interest and enjoyment. No such person can lay down the second volume without a feeling of amazement that so much achievement in high regions of scientific discovery and invention could be crowded into one life, even though that extended far beyond the Psalmist's three score years and ten. Indeed, the book may do much good by telling the public at large how much it is indebted for its safety in travelling, for telegraphic communication from continent to continent and between the old world and the new, and for many other benefits (to say nothing of the advancement of natural knowledge), to patient investigation carried on by one man and his corps of willing students and assistants.

There are a few corrections here and there that we should like to see made in a new edition, but these are not of any great consequence, and need not be here enumerated. We have come to the end of the space allotted to this review, and only a few points here and there have been touched upon. The thronging memories of the past suggest innumerable topics on which we might dwell. All around are memorials of the great man who has passed away and the work he carried through. But it is better to forbear, and in a last word to commend Prof. Thompson's book to all who care to know something of the life and the victories of a leader of the armies of peace.

A. GRAY.

DYNAMIC ELECTRICITY.

Electricity. By H. M. Hobart. Pp. xix+207. (London: Constable and Co., Ltd., 1909.) Price 6*s*. net.

IN this book the author attempts to impart to the reader a fundamental knowledge of dynamic electricity without using mathematics, or rather without giving mathematical proofs of his statements. He evidently believes in the possibility of such study, for in the preface he says that

"Without any accompanying study of other text-books, almost anyone who is in earnest can make good progress in acquiring a fundamental knowledge of the subject of electricity, by a careful study of the present treatise."

Now this is rather an ambitious statement, but if the author had followed the orthodox method of using mathematics in elucidation of experiment he might have succeeded. He has, however, deliberately discarded the use of the most efficient tool we have in the interpretation of experimental results, and thus the task of the reader is made more difficult, and not more easy, as he hoped to make it. The author cannot do entirely without mathematics, or at least without expressing certain relations by mathematical formulæ, but he gives these without showing how they are obtained, merely as statements without proof. Here are a few examples: on p. 59 we are told that a circular conductor 1 cm. long, and carrying 10 amperes, acts on a unit pole in the centre of the circle with a force of 1 dyne. No proof is given for this statement, yet, starting from this, the author develops, also without mathematical proof, the law that the magnetic field round an infinite straight conductor varies inversely as the distance from the conductor. On p. 83, merely as a footnote, we get a simplified version of Minchin's formula for the total flux through a coil of circular cross-section, and on p. 85 Perry's formula for the flux through a coil of rectangular cross-section. On p. 87 we find the well-known formula for the induction in the centre of a long solenoid, but in none of these cases is a proof given.

This tendency to do without mathematical reasoning is surely futile; a reader who does not know even the small amount of mathematics which suffices for the elementary study of electricity had better leave the subject alone; and the reader who has the required mathematical knowledge is not helped by finding the most simple relations set forth in long tables and perfectly obvious diagrams. Yet the book is interesting to the man who knows the subject. He will find many things, which are treated in all text-books in the orthodox way, presented in a different manner, and although the treatment is sometimes rather verbose, it is at any rate original. As regards nomenclature, the originality is perhaps carried a little too far. That the term "kelvin" is used to denote the unit ordinarily called the kilowatt-hour might be passed over as permissible, since some other authors have adopted the same term, though it is by no means generally accepted; but there is no justification for introducing the term "siemens" for the watt-hour. This unit is hardly ever used, and to coin a special term for it is quite unnecessary. The terms "continuous electricity" and "alternating electricity" are also unusual, whilst the abbreviation "ats" for ampere-turns is not very happily chosen.

The first six chapters, dealing with the specific resistance of conductors, the conception of current, voltage, energy, power, and explaining Ohm's law, are very elementary. The definition of the unit of energy, taken as the kilowatt-hour, is unusual. According to the author's nomenclature, the "kelvin" is that amount of energy which will raise the temperature of a ton of water by 0·86° C. This is surely a roundabout way for a book on electricity, especially as the conception of the mechanical equivalent of heat is not used to connect the "kelvin" with the "joule," but the relation between the two units is simply stated in a table.

The following chapters deal with the magnetic field, the E.M.F. generated in moving conductors, alternating currents, inductance, the magnetic circuit, and insulating materials. The passage dealing with the relation between time and current in a circuit to which an E.M.F. is suddenly applied is an object-lesson of the futility of attempting to treat such a subject without mathematical basis. It cannot be done; and thus we find Helmholtz's formula suddenly introduced without any proof, and then worked out at great length algebraically for a special case. Then we get to the time constant and more numerical calculations, with the usual complement of tables and curves. The best chapter in the whole book is that on insulating materials. Here we get on to the solid ground of experimental evidence. Tables and curves are given for the disruptive strength of a great variety of insulating materials, the influence of temperature is discussed, as are also the methods of testing for disruptive strength and the thickness of slot insulation found necessary from practical experience. The specialist who has to design high-pressure machinery will find this part of the book very useful.

Gisbert Kapp.

AN ARTIST-ORNITHOLOGIST IN EGYPT.

Egyptian Birds, for the Most Part seen in the Nile Valley. By Charles Whymper. Pp. x+221; with 51 coloured plates. (London: A. and C. Black, 1909.) Price 20s.

We have nothing but praise for Mr. Whymper's drawings. Being more in the nature of landscapes with birds in the foreground than figures of birds with a suitable background, they naturally gain from an artistic standpoint, and this has not detracted from their value as guides towards identification. Many of the drawings are, indeed, most pleasing pictures, and convey a delightful impression of the surroundings amongst which the visitor to Egypt may expect to see the birds depicted. On the whole, Mr. Whymper has not suffered greatly at the hands of the block-maker, though we may remark generally that the colouring of the plates is more pleasing by artificial light than by daylight, and we imagine that the green legs and feet of the griffon vulture, the purple hues of the chats, and such like inaccuracies in colouring are due to the engraver's or printer's art rather than to the artist's.

Whether the author has been wise in his choice of "types" of Egyptian birds—only some fifty or sixty species in all are figured and described—is perhaps a matter for argument, but in a book which aims at teaching the traveller in Egypt "something of the birds he sees," it seems a waste of opportunity to devote plates and descriptions, amongst so few, to such birds as the kingfisher, house-sparrow, heron, snipe, and lapwing, which every Englishman who takes the smallest interest in birds must know; while the inclusion of the shoebill, which has never occurred in Egypt, because it is a favourite at the Giza Zoological Gardens, is really absurd—one might as well include the giraffe in an account of the mammals of England! The use of the book as an aid to identification is thus very small, for it will help the average Englishman to identify barely forty birds which he does not already know, and the volume is a large one for so small a gain in knowledge.

Turning now to the letterpress, the author disarms minute criticism by his statement that the book is not intended for the ornithologist, but he implies that its purpose is, in some measure at all events, educative, so that we may fairly point out some inaccuracies, for we cannot commend the author's ornithology in the same spirit as we can his art. As an example, we may direct attention to the description of the crested lark, in which not a word is said of there being a number of well-marked geographical races of this bird peculiar to different localities in Egypt—obviously a very interesting point which, had it been explained, would have caused Mr. Whymper's readers to look carefully at the crested larks they saw instead of passing them over as "nearly the commonest birds." Which form is represented in the plate it is difficult to say, but certainly neither the almost black *Galerita cristata nigricans* of the Delta nor the pale, sandy-coloured *G. c. altirostris* found to the south of Cairo could be recognised from the drawing.

Again, on p. 76 the extraordinary statement is made that the red-spotted bluethroat has never occurred on migration in Germany, and that it flies without a halt from Africa to Scandinavia. Because many of the migrants which occur in winter in Egypt are of the same species as those which occur in north-western Europe in summer, it is unreasonable, we think, to suppose that they are the same individuals. The further statement that the bird is but an accidental visitor to Great Britain, and hardly worthy of a place on the list of our birds, should also be corrected, since it has been proved during the last ten years, at all events, to be a regular annual bird of passage in the autumn. We have no wish to criticise unduly, but we think it behoves an author to be even more careful of his facts in a popular book of this kind than in a book intended for readers who would not be so likely to accept his statements unchecked.

The ornithologist reading Mr. Whymper's pages may cull a few observations of interest, such as a note here and there on the winter habits of some of the migrants. The list of birds at the end of the volume is so far from being complete that we cannot think that it has been revised by Mr. M. J. Nicoll, who is credited with having assisted the author in making it "as complete as possible."

THE EVOLUTION OF AGRICULTURE.

Die Entstehung der Pflugkultur. By Dr. Ed. Hahn. Pp. viii+192. (Heidelberg: C. Winter, 1909.) Price 3.60 marks.

IN the study of culture-origins there seem to be three working hypotheses. According to one, institutions and material inventions were, so to speak, "forced" upon man by the various exigencies of his life. "Necessity is the mother of invention." According to another, religion, or rather magic, initiated such steps in progress. A third combines these; a step when made was enabled to persist and be improved by the influence of religion.

But each of these hypotheses, as others, takes into account the psychological factors. How did the idea of an invention occur? It is the first step that counts; given the first step, for instance, in the evolution of the bow, and the rest is easy. How, then, did man hit upon the first step? Among the conditions to be posited are "play" and accident. There is a good deal to be done in the investigation of the first steps of what may be called the primary inventions.

Dr. Eduard Hahn has written many volumes and papers on economic history and culture-origins. He is a suggestive writer, and is always ready with a comparison between modern and primitive "diapasons," in Lamprecht's phrase for social atmospheres. The present volume is more or less supplementary, as an answer to criticisms of his theory of the origins of agriculture.

This theory is the magical-religious. It has been severely criticised, and we must admit that in this re-statement and defence Dr. Hahn fails to convince. His method is almost as elliptic as Prof. Adolf Bastian's. A closely reasoned argument confined to one detail, for instance, the relation of the "Moon Goddess" to the evolution of husbandry, and employing careful analogies when a step is taken from one people to another, or from one culture-stage to another, would have had better results. But he seems to rely on the cumulative effect of data which are of the most diverse nature and value. Thus we have in unequal yoke a piece of folklore from Hesiod or Macrobius, with a savage practice of the Australian Arunta and a German peasant custom. But his theory is too fanciful to be able to rely on such data.

The points of the theory are mainly these: the basis of primitive subsistence was vegetable, not animal. The three-stage hypothesis of hunting, herdsmanship, and husbandry is traversed. The primitive *Hackbau* is distinguished from agriculture proper, *Pflugbau*. Woman was the chief agent in primitive economics, as the "gardener" with her digging-stick. Thus far the theory is sound. But it proceeds to urge the "religious" *origin* of the domestication of animals, of the use of milk, of the wagon and its wheels, and of the plough, all in connection with the cult of the Moon. Much is made of the sporadic indications of the connection of phallicism with the "idea" of ploughing.

Dr. Hahn's sketch of the primitive symbiosis of Headman, Medicine-man, and Woman is good reading. The Medicine-man protects the primitive "crop" from ghostly enemies, and secures for it ghostly strength. The Headman organises material defence, and, when free, the ordinary male hunts. But primitive society was probably not quite like that; in particular it is easy to exaggerate the influence of "religion." A. E. CRAWLEY.

OUR BOOK SHELF.

A Manual of Locomotive Engineering. By W. F. Pettigrew. Third edition, revised. Pp. xv+356. (London: C. Griffin and Co., Ltd., 1909.) Price 21s.

WE had pleasure in noticing the first edition of this book some ten years ago, when a favourable opinion was expressed as to its value as an educational means of assisting students of locomotive engineering in its many phases.

The author claims to have brought the work thoroughly up to date, and, considering the tremendous advances made in this branch of engineering during the last ten or more years, we naturally expect some evidence of really modern practice in the third edition. It is very disappointing to find this is not the case. Plate i. illustrates what the author describes as "the new outside cylinder express engines designed by Mr. W. Adams," &c. As Mr. Adams joined the majority some years ago, and as the engines referred to were designed many years before then, it is absurd to illustrate them as modern practice when the magnificent creations of Mr. Wilson Worsdell on the North-Eastern and those of Mr. McIntosh on the Caledonian are available.

The compounding of locomotives has also been very seriously considered by many engineers, particularly during the last ten or twelve years. The Webb and Worsdell systems being more or less obsolete, one naturally expected to find the Smith system with three cylinders, which originated on the North-Eastern, engine No. 1619 being the prototype, described and illustrated by one of the recent Midland compounds. Another type of compound represented by the four-cylinder engines on the North-Eastern is conspicuous by its absence.

Of the subject of superheat, which is now being seriously considered by most locomotive engineers, we find no reference in this volume. This is surely a serious omission when there are locomotives running on certain railways in this country fitted with the Schmidt system, a system which claims many economies in working when compared with the heavy boiler expenses involved when working with the high pressures necessary with the compound engine.

Although we have considered it necessary to point out that the author's claim of having brought the third edition of this book up to date has more or less failed, it should be clearly understood that its contents are of a valuable nature, and budding locomotive engineers should obtain a copy without delay. It is certainly one of the best books of its kind. The illustrations are good and the general style excellent.

Matter, Spirit, and the Cosmos. Some Suggestions towards a Better Understanding of the Whence and Why of their Existence. By H. Stanley Redgrove. Pp. 124. (London: W. Rider and Son, Ltd., 1910.) Price 2*s*. 6*d*. net.

Mr. Redgrove's theory of matter is that it possesses only a hypothetical reality; we assume its existence only because otherwise the harmony of our individual worlds would be unintelligible. Spirit, he seems to maintain, we know by direct intuition of ourselves—a proposition of great dubiety, if we take spirit in the sense of real substance. But, granting the one a certain, the other a hypothetical objectivity, the objective relation of the two must be determined. Mr. Redgrove holds that God is the ultimate cause of both, spirit the mediate cause of matter. Yet the effect must be regarded as quite distinct and discrete from the cause. It would seem to follow that for God spirit is something analogous to what matter is to us; but this inference is not drawn. Moreover, no reason is given for the ontological subordination of matter to spirit, except the epistemological distinction noticed above; and it might equally be held to prove the ontological subordination of all other spirits to one's own. Mr. Redgrove, indeed, tentatively holds that in telepathy we have direct "sense" of other spirits; but this perception is "symbolic" as well as direct, which means, one must suppose, that it is not truly immediate. The author believes in the immortality of self-conscious beings; but as he also believes that self-consciousness arises out of protoplasmic consciousness by the ordinary processes of the universe, it is not evident why he should assume the impossibility of a relapse into that state. Though these and other difficulties will be met, the book is well worth reading. Mr. Redgrove writes with precision and force, and his discussion is always interesting.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or 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 Colour of Water.

I am reminded by Lord Rayleigh's lecture on this subject of the splendid light-blue colour presented by the tanks of water in which some of the water companies allow the sedimentation to take place of "hard water" which has been treated by Clark's process. I am thinking of those near Caterham and of those at Plumstead. The tanks—to the best of my recollection—are about 20 feet by 40 feet in area and 15 feet deep. The water in the tanks has become perfectly (or nearly) clear, whilst the sides and bottom of the tanks are made brilliantly white by the deposit of calcium carbonate. The intense blue colour is seen at (practically) any angle of vision, and on a sunless, overcast day as vividly as in sunshine. It would be important to ascertain whether the blue colour thus seen is entirely due to the self-colour of the water or whether the phenomenon is in any way due to the minutest white particles of calcium carbonate which are still floating in the apparently clear water, and are acting as do the particles of a blue vapour-cloud. I suppose that it would be an easy thing for a physicist to determine this by the use of a polariscope at the side of the tank.

Also the introduction of black tarpaulin into the tank so as to prevent the reflection of light from the bottom and sides would show whether any amount of blue colour was still exhibited by the water, such colour being then necessarily due to the reflection of light from suspended particles, and not from the sides or bottom. A more satisfactory method would be to draw off (without disturbing the sediment) the blue-looking water into an adjacent tank previously lined with dead-black.

One observation on the colour of water I may venture to record. In a very large porcelain (so-called) bath in a hotel bath-room, where strong sunlight was admitted by a window some 10 feet above the bath, the walls of the room being colourless, I noticed that when the bath was filled to a depth of 20 inches the water had a distinctly blue colour. The porcelain, whilst pure white above, yet *beneath* the water had a distinctly blue appearance, and the intensity of the colour varied with the movement of the water in waves or ripples. The colour was blue rather than greenish-blue, and this I attributed to the pure white of the porcelain as contrasted with the yellowish tint of enamel. The water in question was that supplied in the Hotel Ritz, in Paris (I think that of the Vanne).

E. Ray Lankester.

The Stability of an Aëroplane.

I have been much interested in reading Prof. Bryan's statement on the subject of the stability of an aëroplane, but I cannot agree with him in thinking that the solution of the problem is to come from the mathematical side. I should be the last to decry the use of mathematics in such a case, but if the final result is to be absolutely trustworthy, there must be no doubtful assumptions made during the process.

It does not appear, from the article written by Prof. Bryan, whether he has taken the viscosity of the air into account, but I presume that he has done so. Perhaps, also, his solutions are only meant to apply to the case of an aëroplane flying in a dead calm. The practical difficulty with a flying machine is the natural wind, and if flying machines are to be of any real use they must be able to maintain their stability in ordinary conditions of weather. Now it is obvious that when a flying machine has once left the ground it is quite immaterial to the stability, provided the air motion is perfectly uniform and steady, whether the velocity of the wind be one mile or one hundred miles per hour, since it is only the relative motion of the machine and the air with which we are concerned; but, as a matter of fact, a wind of from ten to twenty miles an hour is fatal to almost every aëroplane, and the reason is not far to seek. The air motion known as wind is not even approximately steady and uniform until at least a height of 1000 feet is reached, and on some days there is no uniformity about it until much greater heights are attained. The supposition made, therefore, that the motion is uniform is incorrect, and if this assumption has been made by Prof. Bryan it limits the use of his equations to times of perfect calm.

He has probably also assumed that the flying machine, or at least the separate parts of it, may be treated as a rigid body. The small gliders made of thin mica, and described by Mr. Lanchester, may, no doubt, be treated as rigid, but cloth or canvas forms an important part of an aëroplane, and however tightly it may be stretched it certainly is not equivalent to a rigid sheet, but must yield under varying pressure.

My practical experience on this subject is with kites, and although there are fundamental differences between a kite and a flying machine, there are many points of resemblance, and it is probable that if the question of the stability of a kite could be completely elucidated, that of the stability of an aëroplane would follow. Almost any kite will fly in a steady wind of moderate velocity, but, so far as I know, there is no kite that will remain stable when the wind increases beyond a certain value. The limit with the kites used here is about forty-five to fifty miles an hour at a height of 1500 feet. The question is, Why do they become unstable? There are, perhaps, three reasons. The flying of a kite depends on gravity, for a weightless kite could not fly, as there would be no directive force. As the wind pressures increase, the necessary relationship between the magnitudes of the pressures and the weight is lost, and the kite becomes unstable. A cure, perhaps, lies in increasing the dead weight. Secondly, the stresses produced by the strong wind very likely deform the kite. It is not possible to meet this by increased strength, for increased strength means stronger, and therefore heavier, materials, and hence, unlike a dead weight at the centre of gravity, a greater moment of inertia, which, as I have long known from practical experience, and Mr. Lanchester has shown from the theoretical side, is inimical to stability. Thirdly, it may be that there is a certain critical velocity, like that of water in a pipe, beyond which the motion over the edges of the sails becomes turbulent, and the form of the stream lines suddenly changes.

These points can best be cleared up by extensive experimental work, and I much regret that no such work is being done.

W. H. DINES.

Pyrton Hill.

IT was difficult to prevent my article from running to ten times its present length, and a similar difficulty occurs in this letter. I can only state that the more I have examined the problem of stability the more I have been brought to conclusions exactly the opposite to those expressed in Mr. Dines's letter. My original view was to limit the mathematical investigation to the formation of the biquadratics and their discriminants, leaving their coefficients to be determined by experiment. In several popular articles I have advocated such experiments. Further experience has shown that there was little prospect of any conclusions of a practical character being obtained without a considerable further development of the problem from the mathematical side.

Moreover, experience has led me to believe that the English practical man is sometimes right when he says that if you cannot get a complete solution of a problem you ought to try to obtain the nearest approach to it that you can, and, further, that an admittedly approximate solution is often more useful than a more complicated exact one. In the present case the methods are perfectly general, and while it would have been futile to start, in the first instance, by making the problem too complicated, there is little difficulty in introducing any necessary modifications subsequently.

In regard to the assumption of uniform relative velocity, surely Mr. Dines is confusing the issues between stability and something else. The very notion of *stability* implies the existence of a state of equilibrium or of steady motion. The behaviour of an aëroplane or kite in a turbulent atmosphere is a problem, not of stability, but of forced oscillations. The effect of these oscillations is to modify the motion of the kite; but it is necessary in the theory of forced oscillations to assume as a standard of comparison the state of equilibrium or steady motion which would exist if the disturbing forces were absent, and the character of the forced oscillations will depend vitally upon whether this state of equilibrium is stable or unstable. The first thing is to investigate the free oscillations, but there is nothing to prevent the investigation extending to forced oscillations as well. It is only a question of time and opportunity. Meanwhile, aviators are performing record flights on aëroplanes which do not satisfy the conditions of stability, and Mr. Dines's turbulent air currents are getting blamed for much that is not their fault. No solution of the problem can be final which does not completely separate the effects of free and forced oscillations. I do not see how this can be done by purely experimental methods of investigation, and surely the questions which Mr. Dines raises in connection with the behaviour of kites refer to this very point. He has, in fact, stated another problem for the mathematician.

Again, like Mr. Dines, I was at first of opinion that it might be possible to establish a simple connection between the stability of an aëroplane and that of a kite, and I suggested this problem to Mr. Harper. The investigation turned out to be more complicated and less likely to lead to any practical conclusions than was originally anticipated. With so many other problems on hand, it appeared desirable to give this one up for the present. I do not think Mr. Dines will find it possible to obtain an experimental solution. If he can, a great deal of trouble will be saved; but so many variables enter into the problem that it appears to me necessary to start with some idea as to what the connection is likely to be, *i.e.* with some kind of a mathematical theory as a starting point.

When Newton published his "Principia" it would have been an easy matter for a forerunner of Mr. Dines to raise objections to this attempt to solve problems relating to moving bodies by applications of the laws of motion on the ground that the motions must largely depend on air resistance, friction, the earth's rotation, and other causes, and that a solution which did not take all these effects simultaneously into account could be of no practical value. Similarly, it might have been objected that the solution of the problem of stability of ships could not be approached by means of the theory of the metacentre on the ground that it failed to take account of wave motion, the velocity of the ship, the effects of the wind, and such resistances as viscosity. I venture to suggest that if the above problems had been attacked by purely experimental methods alone, we might still have been in the dark as to their solutions.

In my article I alluded to difficulties caused by "want of opportunity," but out of fairness reference ought to have been made to the similar difficulties referred to in Mr. Lanchester's book. Had his investigations been published when they were made, a large amount of work might now have been accomplished which is still undone.

It is only fair also to add that since the appearance of the note I have had some correspondence with the editor of the *Aëronautical Journal*, and I hope he will succeed in maintaining the same high standard in its published papers of a mathematical character as in its illustrated articles on general aëronautics.

G. H. BRYAN.

Colour-Blindness.

IN the issue of NATURE of January 27 there is a discussion of colour-blindness, with particular reference to the case of Mr. John Trattles, whose colour-vision seems to have been difficult to determine. It is not my purpose to discuss the peculiarities of this case, or the methods of examination used by the Board of Trade. As a worker in this branch of science, however, I may be permitted to say that in any case of supposed defective colour-vision there need be no appeal from the opinion of Sir William Abney, who is so justly celebrated on both sides of the Atlantic for his researches on the perception of colour.

Since, however, in the case of Mr. Trattles, and possibly in others as well, the evidence was not regarded as conclusive by all the examiners, it is most desirable that some method should be used about which there could be no doubt whatever. Such a method, I believe, is one founded on the exact measurement of the persistence of vision of colours throughout the spectrum, when the frequency of flicker is at its critical value. The only thing the person under examination has to do is to adjust the speed of a sectored disc so that the flickering of the part of the spectrum under observation just ceases. The speed of the disc may be automatically registered on a chronograph by electrical means. A series of measurements throughout the spectrum when plotted gives a "persistency curve," which can readily be compared with a similar curve for a normal eye. The great advantage of this test is that it is purely mechanical, and does not involve the handling of coloured materials or the judging of colours in any way by the candidate.

A careful study by this method of twenty-six cases of colour-blindness which I made some years ago ("Persistence of Vision in Colour-blind Subjects," *Phys. Rev.*, vol. xv., 1902) showed such systematic differences between eyes with normal and those with abnormal colour-vision that I am convinced it is the most exact method yet used for the study, not only of colour-blindness, but also of normal colour-perception. I can the more readily express such an opinion inasmuch as this method, though used very extensively by myself, was originally devised by Prof. E. L. Nichols.

In the article in Nature there is the statement that in the study of colour-blindness "there is none of that accuracy of definition in the scientific picture which rejoices the heart of the physicist." To some extent this may, perhaps, be true, especially for very strong or weak intensities of stimulus. On the basis of the cases I have referred to above, I venture to assert that, for ordinary daylight, there is far more "accuracy of definition" than is usually supposed to exist. I do not know how many cases of colour-blindness must be studied to render the conclusions drawn therefrom reasonably sure, but those to which I refer can readily be divided into distinct classes on the basis of three fundamental colour-sensations, red, green, and violet.

Holmgren, I believe, first pointed out the possibility of the following varieties of colour-blindness:—

Red-blindness ... ... Green-blindness ... ... Violet-blindness	Defective in *one* colour sensation.
Red-green blindness ... Red-violet blindness ... Green-violet blindness ...	Defective in *two* colour sensations.
Red-green-violet blindness or total colour-blindness	Defective in *three* colour sensations.

In the paper on colour-blindness referred to above, there is, I believe, a demonstration of the existence of each of the above types with the single exception of violet-blindness. This classification, which was arrived at by means of persistency curves, seems to me to be as definite as could almost be desired.

I would therefore suggest this method for the examination of at least doubtful cases of defective colour-vision. The only objection is that the measurements, while simple and easily performed, are somewhat tedious if the spectrum is to be thoroughly examined.

Frank Allen.

Physics Department, University of Manitoba,
Winnipeg, February 11.

Practice and Knowledge.

Mr. and Mrs. Howard in Nature of February 17 show that "the past history of agricultural science furnishes several examples of belated explanations of the utility of practices the value of which has long been a tradition among practical men." In other departments of life practice in advance of knowledge is frequent, and there is one which struck me recently, and may have been observed by others, which is the practice of blowing hot and cold with the mouth which Æsop makes use of in his fable of the "Satyr and the Traveller," and has given rise to the common disparaging saying of "blowing hot and cold."

Some may suppose that the whole explanation of blowing hot and cold may be in the difference in temperature of the two bodies blown on; the Traveller's hands in Æsop's fable were colder than his breath, while the heated mulled wine was warmer. This, however, is only a partial explanation. We have unconsciously acquired the practice of blowing at different temperatures. If we wish to warm our hands we open the mouth wide and direct a slow moving current of air to them, or, more properly expressed, we breathe on our hands. This current has nearly the body temperature; but when we wish to blow cold we purse in the lips until there is only a small opening, as in whistling, and discharge a fine jet of air under pressure. This jet entangles a large amount of air with it, and when it arrives at the hot surface its temperature is much lower than that of the breath. Should the hot surface be also moist, the current of air quickens the evaporation, and so hastens the cooling.

In passing, it may be noticed here that Æsop and the modern use of the expression "blowing hot and cold" seem to have missed the mark. The objects blown on are not the same, but different, and require and receive different treatment. It is no disparagement to say of a man that he blew hot on a scheme which seemed to him to require encouragement, while he blew cold on another he thought ought to be suppressed. Æsop putting the words into the mouth of a being of the type of a Satyr seems to suggest he was not quite sure he had given the highest interpretation of the incident recorded in the fable.

John Aitken.

Accelerated Velocity of Jupiter's Red Spot Hollow.

The longitude of the middle of the Hollow has shown a comparatively rapid diminution since the beginning of the present apparition, as the figures below clearly indicate:—

Month	Mean longitude	Diminution	Month	Mean longitude	Diminution
	°	°		°	°
1909 October ...	15·3 ...	—	1910 January ...	8·8 ...	3·0
1909 November ...	13·3 ...	2·0	1910 February ...	7·4 ...	1·4
1909 December ...	11·8 ...	1·5			

From its estimated position on October 25 and February 25 (the first and last dates of observation in the above table), a rotation period of 9h. 55m. 37·9s. (287 rotations) has been deduced. This is 2·7 seconds shorter than the adopted period.

If the present accelerated rate of motion continues until June next, the centre of the Hollow will arrive at λ 0°, or, rather, its longitude will coincide with the zero meridian of system ii.

Now this quicker velocity became evident towards the end of the last apparition. An examination of my transit-chart of the Red Spot region for that epoch shows that, up to the beginning of May, 1909, the Hollow exhibited a normal monthly increase in longitude of 1·0°. Subsequently it began to move decidedly quicker, and this acceleration has been well maintained up to the present, as will thus be seen:—

Date	λ	Elapsed rotations	Rotation period	Remarks
	°		h. m. s.	
1908 Dec. 20 ... 1909 May 2 ...	13·6 18·1	321 ...	9 55 42·1	May 2 chosen as approximate date of change in velocity
1909 May 2 ... 1909 June 12 ...	18·1 18·4	99 ...	9 55 40·9	The last transit of the apparition was taken on June 12
1909 June 12 ... 1909 Oct. 25 ...	18·4 15·3	327 ...	9 55 40·5	Planet invisible for greater part of time between the two dates
1909 Oct. 25 ... 1910 Feb. 25 ...	15·3 7·0	287 ...	9 55 37·9	Hollow in conjunction with S. Tropical Dark Area, since January

The approximate date when the present accelerated velocity first commenced may be regarded as May 2, 1909.

The recent behaviour of the Hollow, or the Red Spot, is attributed to one well-known phenomenon. Once about every twenty-three months the Great South Tropical Dark Area passes rapidly by the Spot, and on each occasion the latter temporarily participates in its movements. As it is now two years since we witnessed the last of these periodical occurrences, the dark matter, having swept round the planet, is once again involving the region of the Red Spot. The recent accelerated motion of the Hollow, therefore, was fully anticipated.

March 4. Scriven Bolton.

A Radium Experiment.

It is usual to demonstrate the ionising property of radium by discharging an electroscope. The reverse experiment of charging an electroscope, or Leyden jar, is more effective, and can be made to ring a bell.

If a wire, about 6 inches in length, is coated with a salt of radium and placed *in contact* with the knob of an electroscope, the latter will quickly become charged if any charged body is placed within 2 or 3 feet. A small Wimshurst machine is very convenient for the demonstration, as it can be easily turned about to reverse the charge, or placed equatorially, when no effect is produced.

It is a good plan to arrange the leaf of the electroscope to discharge itself automatically to earth at a divergence of about 45 degrees; then the charging is repeated so long as a charged body is in the vicinity. Instead of sending the discharge to earth it may pass into a coherer, and so ring a bell or give a record.

When an induction coil is used it is easy to show that the prepared electroscope will keep on receiving a charge for some minutes after the coil is stopped; for instance, after working an 18-inch coil for one minute, some charge was given to a delicate radium-tipped electroscope when brought into the room four minutes later.

This duration of charge on air can be distinctly shown by filling a large paper bag with charged air and rapidly conveying the same to a Wilson electroscope in another room.

This is obviously due to a residual charge in the air, which persists long after re-combination of mixed ions. This arrangement of a radio-active body near, or, better, in actual contact with, a delicate electroscope is a very sensitive detector. The effect is not quite so good if the radio-active coated wire is placed in contact with the charged body, leaving the electroscope free. Upon exploring the charged air of a room, it is usually found to be divided into two areas of opposite charge; these can be mixed by waving an umbrella, so yielding a neutral mixture.

The fact that a charge is so easily acquired by an electroscope must be taken into consideration during delicate testing, for the mere act of withdrawing a vulcanite pen from the pocket will give a negative charge to a distant electroscope in ionised air.

F. HARRISON GLEW.

156 Clapham Road, London, February 5.

SUBSTITUTES FOR RUBBER.

THE present demand for india-rubber naturally directs attention to those articles which, to a greater or less degree, may serve to replace rubber in its industrial applications, and so help in conserving the supply.

Of such articles a very large number have been proposed. Those in actual use to any considerable extent are, however, relatively few. For present purposes the various surrogates may be distinguished as (1) rubber-substitutes proper, consisting wholly of ingredients other than rubber; (2) composite or "artificial" rubbers, which contain a certain proportion of natural rubber worked up with other substances; and (3) true synthetic rubber, namely, a product containing the rubber molecule synthesised in the laboratory or factory by chemical means from simpler compounds.

At present the first of these classes is commercially the most important. Scores of recipes are in existence, including very diverse ingredients; but the basis of most is a modified oil. At first sight there seems little suggestion of india-rubber in the properties of an ordinary vegetable oil, but a simple experiment will indicate the kind of modification which certain oils readily undergo, and which help to fit them for use as rubber substitutes. If we test the drying properties of boiled linseed oil by spreading a little of it over a slip of glass and allowing it to dry, a film of oxidised oil is eventually obtained, having a certain modicum of toughness and elasticity. The liquid oil has taken up oxygen, and thereby become converted into a more or less elastic solid. Tung-oil substitute is essentially such an oxidised product, manufactured by heating the raw oil until it has absorbed enough oxygen to cause it to thicken and become solid on cooling, when it is powdered and worked up with a little petroleum.

In a somewhat similar way the oils can be made to take up sulphur, becoming thereby solid, and endowed in some degree with elastic properties. The treatment is analogous to the "vulcanisation" of rubber. "Brown" or "black" substitutes are manufactured by heating the oil with sulphur, a process corresponding to the "hot cure" method of vulcanisation. "White" substitutes may be made by merely mixing the oil, cold, with 20 to 40 per cent. of sulphur chloride; or, better, by first dissolving the oil in a suitable solvent such as carbon tetrachloride. This resembles the "cold cure" process used in vulcanising rubber. Colza oil is largely used for these purposes, but various others are available—linseed, maize, arachis, and castor oils, for example. The chemical reaction involved is a somewhat complicated one, but probably it consists mainly in the formation of what chemists term an "addition-product." The proportion of sulphur taken up by the substitutes varies rather widely, ranging from 5 to upwards of 15 per cent. As would be expected, oils which have previously been oxidised to a notable extent (*e.g.* "blown" oils) require less sulphur to saturate them than do the natural oils.

"Nitrated" oils are also used as the basis of some rubber surrogates. Thus one well-known product is a solution of a nitro-cellulose in linseed or castor oil which has been nitrated by treatment with a mixture of nitric and sulphuric acids. Other such articles are made by oxidising the nitrated oil with lead peroxide, or by simply heating it in air.

These oxidised, sulphured, and nitrated oils, in one form or another, are largely used as substitutes for rubber. Of the other substitutes proposed, a few examples may be given, to indicate something of their general nature.

First there are those which, while still retaining oil as one ingredient, include also other important constituents. Thus, "Fenton's rubber" is a mixture of oils with tar, pitch, and creosote; which mixture, when digested with nitric acid, gives a toughened mass, and this on heating yields an elastic product simulating rubber. "Russian" substitute, said to be useful for covering telegraph cables, contains as ingredients wood-tar, hemp and linseed oils, ozokerite, spermaceti, and sulphur. "Oxolin" is made by impregnating fibrous material such as jute or hemp with linseed oil, oxidising the oily mass with warm air, and working the product up between rollers into a coherent mass, which can then be vulcanised by heating it with sulphur.

In another category of substitutes oil plays only a subordinate part, or is altogether dispensed with. Thus "Jones's substitute" is stated to be made from various gums and gum-like products as the chief constituents. In W. H. Perkin's patent (23,031/07), gelatine or glue is dissolved in creosote and then treated with some reagent—potassium bichromate, formaldehyde, or tannic acid—which will render the gelatine or glue insoluble; after "setting," the mass obtained is digested with acetone to make it firmer. "Textiloid" has for its ingredients various resins, nitrocellulose, and camphor. As a curiosity in this class may be mentioned "grape rubber," produced from the skins of grapes by means of pressure; it is not, however, a commercial article. Finally, though this can only be a substitute for rubber in very hard articles, we may mention the interesting material, "bakelite," recently introduced by Dr. L. H. Baekeland. It is a condensation-product of formaldehyde and phenol, which can be moulded as desired, and afterwards hardened.

In what sense are the foregoing articles and their likes to be considered as "substitutes" for rubber? Some persons are disposed to deny them any right to the title, and would look upon them as mere adulterants whenever used partially to replace rubber in what would otherwise be an all-rubber article. Others admit, though sometimes grudgingly, that there is a place which such substitutes can usefully fill. Much depends on what the article is sold as, and on what use it is to be put to. Not all the special qualities of rubber are wanted in all the products for which it is employed. A door-mat is one thing, a bicycle tyre quite another. Where a high degree of elasticity is not really needed, as, for instance, in waterproof goods and electrical insulating work, there is a legitimate field for substitutes which may serve the required purpose. Even here they may not be equal to rubber, but they find their justification in their lower cost. After all, we do not need razors to cut sticks with.

It may be said at once that no substitute is equal to rubber in every respect. Chemically, the latter is a very inert substance—much more so than the substitutes. Hence, even if the latter were not otherwise inferior, they would be less durable than rubber under certain conditions. They are nearly all acted upon more or less readily in circumstances where rubber remains unharmed. The modified oils, in fact, are still oils in the sense that they remain glycerides, decomposable by alkalies, as also by steam under pressure. If used for articles exposed to these agencies, they fail in durability, whatever their excellences otherwise.

The fact that substitutes of this class are readily saponifiable by alkali makes it an easy matter to detect them by analysis when compounded with true rubber. As a rule, the proportion of substitute used is from 5 to 25 per cent., and even the smaller quantity is recognisable.

Of the composite rubbers (or "artificial rubbers," as they are sometimes called), one preparation, which has been made in quantity, and is said to be excellent for many purposes, has for its basis Guayule rubber incorporated with certain gums. Another such article is compounded of natural rubber and some other substance of vegetable origin, probably a latex or a gum, reputed to contain the same chemical elements as rubber and in much the same proportion. Such articles are, of course, only partially "substitutes" for rubber, and their cost rises with that of the latter ingredient. Moreover, if any very large demand for them arose, there is always the possibility that the supply of gums and latices would become insufficient, and the advantage of lower cost would thus tend to disappear.

Coming now to true synthetic rubber; a question often asked is whether there exists any probability of such an article being manufactured and displacing natural rubber, either wholly or to any large extent. Will rubber plantations go the way of madder fields and indigo cultivation? Well, the future is on the knees of the gods. In the face of the precedents just mentioned, to say nothing of others, he would be a bold man who would venture to say that even the best quality of rubber may not some day be made on a commercial scale from cheaper materials such as beet sugar and calcium carbide. But the day is not yet. There are beginnings; there are clear indications of the direction in which to proceed; there is distinct progress to note. But there is still some distance to go, and the end of the journey may not be even in sight.

India-rubber chemically is essentially a polymerised terpene. An article patented some time ago, and named "turpentine rubber," appears to foreshadow a synthesis of true rubber. Turpentine is a mixture of terpenes, and the article in question was to be obtained by passing turpentine through a hot tube, and treating the resulting vapours with hydrochloric acid. The result is a solid condensation-product; and the idea at the base of the process appears to be the production of polymerised terpenes having some of the elastic properties of rubber.

A more promising, because a more scientific way, is that outlined in Heinemann's patent No. 21,772 of 1907. Here a true synthesis is attempted. It is based upon the well-known fact that rubber is probably a polymer of the semi-terpene isoprene. The first step is the production of the unsaturated hydrocarbon divinyl, $CH_2 : CH.CH : CH_2$. This is obtained by passing mixed acetylene and ethylene gases through a heated tube. With methyl chloride, divinyl yields isoprene [methyl divinyl, $CH_2 : C(CH_3).CH : CH_2$]; and the isoprene on treatment with strong hydrochloric acid is converted by a union of molecules into a substance closely resembling caoutchouc, if not identical with it. The raw materials, so to speak, are thus acetylene, ethylene, and methyl chloride, which are themselves obtained by any of the ordinary methods, *e.g.* from calcium carbide, alcohol, and beet sugar residues respectively.

The question is, can this or some other comparatively simple synthesis, theoretically quite possible as a laboratory operation, be translated into a practicable and profitable mode of manufacture on a large scale? One of the first doubts to arise is whether the synthesised caoutchouc will have the physical properties of natural rubber; or whether these, by any course of treatment, can be imparted to it. This doubt resolved, there comes the question of economical production in competition with the natural product. Much time and thought have been spent on the problem of synthetic rubber, and it is safe to conclude that there will yet be many a headache before it is solved. Judging by what is known to have been done rather than by the promises, owners of rubber plantations may for the present sleep peacefully in their beds.

C. SIMMONDS.

REPORT OF THE ROYAL COMMISSION ON CANALS.

THE Royal Commission on Canals and Inland Navigation, the final report of which has recently been issued, was appointed in March, 1906, and consisted of nineteen members, Lord Shuttleworth being chairman. Their instructions were to inquire into the present condition and financial position of the inland waterways of the United Kingdom; to report as to the causes which have operated to prevent the carrying out of improvements by private enterprise; as to improvements desirable in order to complete a through communication by water between the centres of commercial industry, and with the sea; the prospect of benefit to the trade of the country compatible with a reasonable return on the probable cost; the expediency of canals being acquired by public bodies; and the methods by which funds could be provided for their purchase and improvement.

Seven reports and returns have already been issued, and there are four more to follow, including that on the Irish waterways.

The Commission held 106 sittings, and examined 266 canal experts, traders, and others interested in the subject. They personally inspected the most important waterways in this country, and some of those in France, Belgium, Germany, and Holland, and obtained a report from an assistant commissioner on the inland waterways of the Continent.

The final report now issued covers 234 folio pages. It commences with an interesting history of British waterways, and then, seriatim, deals with the different questions submitted for consideration, and concludes with the recommendations at which the commissioners have arrived. These are not unanimous, the minority reports being also given.

Briefly, these recommendations are:—

The formation of a Central Waterway Board, and the transfer to this board of four central lines of canals connecting Birmingham, as the most central trading town of the Midland district, with London, Hull, Bristol, and Liverpool.

If this waterway board, after further investigation, and if satisfied that with regard to general benefit to trade and financial considerations such a course is desirable, it should be empowered to enlarge and improve the existing waterways so as to afford through communication for barges, of 100 tons, between the Midland district and the sea-ports.

The estimate given in the report for constructional works for these four waterways is 17½ millions, the money required for the purpose to be guaranteed by the State. The cost of maintenance, interest, and sinking fund is put at one million.

As already stated, the report is not unanimous. Five of the members sign it with certain reservations, and three members have given separate reports.

The reservations of the five members express their disagreement practically with all the recommendations, their agreement extending only to the historical part, the Scotch scheme, and certain minor matters.

The majority do not appear to have much faith in the scheme they recommend, as they only advise that it shall be carried out if the proposed waterway board is satisfied, after further inquiry, that this would be desirable. They admit that it would not be remunerative, and that the loss would have to be met by the State; that it would be of no benefit to the traders in other parts of England, and that the outlay could only be justified by the advantage it might be to the commerce of the country generally. It is also admitted that even with an improved system of internal waterways a large part of the traffic in goods and minerals must still be carried by the railways, that the system of trade in this country is now so carried on that the traders no longer keep stores of merchandise, but rely on quick and certain delivery of minerals and heavy goods in small consignments, conditions which the canals cannot comply with, and that, owing to this, the introduction of large trucks, which are used for the long distances traversed in the United States, has not been a success here, and this objection would apply with even greater force to barges carrying loads of 100 tons. It is also admitted that if improved waterways were really wanted there would not have been any difficulty in this being carried out by private enterprise.

As to the estimate for carrying out the scheme, this does not include the purchase of the existing waterways, nor the cost of several items such as wharves, warehouses, terminal accommodation, Parliamentary and legal and engineering expenses. In one of the minority reports, the cost of construction and other matters included in the majority report is put at about one-third more than that given.

The evidence given also clearly shows that there is not any analogy between the conditions attaching to the waterways of this country and those on the Continent, which have been developed and improved by State aid, due to the different geographical conditions and the much longer distances over which inland transport extends.

Of the minority reports, that of Mr. Inglis, the present president of the Institution of Civil Engineers, and formerly chief engineer, and now general manager, of the Great Western Railway Company, is a very able defence of the railway companies and their dealings with canals. He points out the injustice of any State-aided effort to revive an obsolete and unsuitable mode of transit, to the detriment of the railways, which have been constructed entirely by private enterprise, and the shareholders of which receive less than three per cent. on the capital expended.

Mr. Remnant, who is a barrister, states his disagreement to the recommendations of the majority of the commissioners on the ground that these are inconclusive and left for future consideration by the proposed waterway board, and that the evidence does not warrant the conclusions arrived at on economic grounds.

Mr. Davison, who is a civil engineer, criticises the findings as to the transport and financial features, and his report contains in a brief form the substance of all the arguments that can be brought against the policy of State acquisition of the waterways. He is of opinion that it is extremely improbable that the traffic estimated for the proposed improved canals would be forthcoming, and that the estimate of the cost for these does not include important charges, and that no attempt is made to arrive at the ultimate cost.

DR. E. PERCEVAL WRIGHT.

WITH the death of Edward Perceval Wright one of the links connecting the old school of naturalists with the modern students of biology is severed. Wright was born in Dublin in 1834, where his father was a barrister. He early evinced a keen interest in natural history, and his enthusiasm in forwarding its study led him to commence to publish, in 1854, the year after his matriculation in Dublin University, a quarterly journal devoted to natural science. It was called the *Natural History Review*, and its publication was continued until 1866. In this journal, in the *Quarterly Journal of Microscopical Science*, in the Transactions of the Linnean Society, the *Journal of Botany*, and in the British Association Reports, he published during the next twelve years a series of papers on the fauna of the south and west coasts of Ireland. His undergraduate studies in botany were pursued under the guidance of Prof. G. J. Allman, and as a student he came into contact with W. H. Harvey, who was then keeper of the Herbarium in Trinity College, and of whom Wright always spoke with the warmest appreciation. In 1858 Wright was appointed lecturer in zoology and director of the Natural History Museum of Trinity College. About the same time he was appointed lecturer in botany in the medical school attached to Dr. Steevens's Hospital. It is surprising to find that while he was thus engaged actively in research and teaching, he also found time to prosecute medical studies with such success that by 1865 he had begun to establish a position for himself among Dublin oculists. But he did not remain in practice long, and, finding it impossible to pursue his medical work together with his duties as *locum tenens* in the chair of botany during the illness of Harvey, who was then the University professor, Wright definitely gave up his ophthalmological work in 1866. During the same period his attention was directed to the finds of fossils in the Kilkenny Coal-measures, and in 1866 he published, in collaboration with T. H. Huxley, an account of the fossil vertebrata from the Jarrow colliery.

In 1867 Wright went to the Seychelles Islands to study the fauna and flora of that group. Unfortunately all his collecting apparatus and preserving materials were lost on the way out by shipwreck. Notwithstanding this misfortune he succeeded in bringing back an important collection of animals and plants, and in the following years was able to publish a series of papers describing the new and interesting forms collected. These papers, together with others on collections made in Portugal and Sicily in 1868, appeared in the *Annals and Magazine of Natural History*, in the Transactions of the Royal Irish Academy, and in the British Association Reports, 1868–76. Shortly after his return from his travels Wright was appointed to the chair of botany in Trinity College, and he held this position until he resigned it in 1904. In 1874 he was elected secretary of the Royal Irish Academy. While University professor of botany, Wright was chiefly interested in herbarium work, and he devoted much labour and enthusiasm to arranging and indexing the valuable collection of plants belonging to the college. Hence it was no ordinary blow to him when, in 1882, through an ill-considered order of the college authorities, he found the whole collection thrown into confusion, and most of his own labours in the herbarium, and those of his predecessors, dissipated. His despondency was short-lived, and he soon buckled to the weary work of arranging once more, and during the next ten years accomplished, practically without assistance, the task of putting the collection into a condition fit for reference. While at this work he was also engaged, in collaboration with Th. Studer, on the report on the Alcyonaria of the *Challenger* expedition.

Speaking from the experience of one who knew only the latter end of Wright's life, his wide human sympathies won the affection of those who came into close contact with him. He was most desirous to forward younger men's work in science, and generously helped them by all the means in his power. It was a pleasure to him to put his varied and often recondite knowledge of the literature of natural science at their disposal. He showed the liveliest appreciation of the results obtained by the more modern generation of biologists. As a teacher he was more than ordinarily successful in stimulating the enthusiasm of his classes and in implanting in them the desire to carry out investigation. He had considerable powers as a conversationalist, and his travelling companions remained his life-long friends. At the same time he was sensitive to a fault, so that he was often misunderstood by those who were not intimately acquainted with him.

Besides his scientific work, he was deeply interested in antiquarian research, and, as president of the Royal Society of Antiquaries, Ireland, exerted himself by every means in his power to forward the investigation of the antiquities of Ireland. His whole career was marked with affection for his University, and some years before his death he presented Trinity College with a valuable collection of botanical books and journals. Since 1904 his health had been gradually failing, and his previous energetic temperament seemed to desert him. The announcement of his death, which took place on March 4, was a grief but not a surprise to his friends.

NOTES.

The fourth annual meeting of the British Science Guild will be held at the Mansion House, at 4 p.m., on Friday, March 18, under the presidency of the Lord Mayor. An address will be delivered by the Right Hon. R. B. Haldane, F.R.S., and it is expected that Lord Strathcona, the Right Hon. Sir George Reid, Dr. Warren (the Vice-Chancellor of Oxford University), Sir Ernest Shackleton, Sir Alfred Keogh, and Colonel Sir John Young will address the meeting.

We announce with great regret the death on March 4, in his fifty-fourth year, of Prof. K. J. Ångström, professor of physics in the Royal University of Upsala.

The death is announced, on March 14, of Dr. H. Landolt, professor of chemistry at the University of Berlin from 1891 until 1905, at seventy-eight years of age.

The annual general meeting of the Chemical Society will be held on Friday, March 18, when Prof. Harold B. Dixon, F.R.S., will deliver the presidential address, entitled "The Union of Hydrogen and Oxygen in Flame."

We notice with regret the announcement of the death, on March 14, of Dr. J. C. Brown, professor of chemistry in the University of Liverpool, at sixty-seven years of age.

We regret to see the announcement of the death of Prof. E. Philippi, professor of geology and palæontology in the University of Jena, and geologist to the German Antarctic Expedition of 1901–3.

Messrs. Sanders and Co., 71 Shaftesbury Avenue, are making arrangements to hold a series of one-man exhibitions from leaders of natural-history work in photography. The first will open early in May, and will be the work of Mr. Richard Kearton. Admission will be on presentation of visiting card.

A Reuter message from Berlin announces that a regular airship passenger service will be started on May 15 from Munich to Starnberg and Ober-Ammergau. A dirigible of the Parseval type will be used, with a gas capacity of 6700 cubic metres. It will carry twelve passengers besides the crew. It will have two motors, each of 100 horse-power, and will make trips alternately to Starnberg and Ober-Ammergau.

The King of the Belgians has announced his intention to make a grant of 40,000*l.* for investigations into the nature and prevention of sleeping sickness. Stations for the study of the disease will be established, the number of doctors will be doubled, and missionaries will be trained in preventive measures at Leopoldville. King Albert will also give 20,000*l.* for the provision of hospitals for natives of the Congo.

The committee organised a few weeks ago to arrange for a thorough scientific investigation of pellagra appeals for funds to enable it to commission Dr. Sambon to undertake the inquiry. The minimum sum required is 600*l.*, but so far only 230*l.* has been subscribed, including 150*l.* promised by the Colonial Office on condition that a further amount of 450*l.* is found. Subscriptions should be sent to Mr. James Cantlie, honorary secretary and treasurer, Pellagra Investigation Committee, 140 Harley Street, W.

We have been asked to state that the annual general meeting of the Society of Dyers and Colourists will be held this year in the Municipal School of Technology, Manchester, on Friday, March 18, at 4 p.m., when the retiring president, Prof. R. Meldola, F.R.S., will deliver an address on "Tinctorial Chemistry—Ancient and Modern." The presidency of the society is to be taken over by Sir Frederick Cawley, Bart., M.P.

THE President of the Board of Trade has appointed a new Advisory Committee on Commercial Intelligence. The chairman of the committee will be the President of the Board of Trade, or, in his absence, the senior Board of Trade representative present. The committee is to hold office for three years. The committee is appointed to advise the Board of Trade (*a*) on the work of the Commercial Intelligence Branch and on such matters relating to foreign tariffs and other commercial questions as the Board may refer to them, and (*b*) as to commercial missions abroad or other means of obtaining and diffusing information for the benefit of British trade.

AN international expedition started on March 13 for the Peak of Teneriffe to investigate the effect of high altitudes and sunshine on medical and biological processes. From a note in the *Times* of March 12 it appears that the party included Prof. Pannwitz, of Charlottenburg, the president of the International Commission for the Study of Biological and Medical Effects of High Altitudes and Sunshine; Dr. Barcroft and Dr. Douglas (Cambridge University), representing England; Prof. Zuntz and Dr. Neuberg, representing Germany; Dr. Mascat and Dr. Plasse, representing France; and Prof. During and Dr. H. von Schrötter, representing Austria. Prof. Zuntz has already done work in this direction on Monte Rosa, and his observations will be elaborated by the expedition. Preliminary meteorological work has been done by Prof. Hergesell. Dr. J. Mascat, of Paris, has joined the expedition for the purpose of studying Halley's comet under the favourable conditions afforded by the Peak of Teneriffe. Prof. Müller and Dr. Kron, of the Potsdam Observatory, are expected to join the expedition within a week or two.

THE annual general meeting of the Ray Society was held on March 10. The report of the council stated that the society's publication for 1909, a supplementary part of the "British Nudibranchiate Mollusca," has been delayed owing to Sir Charles Eliot's absence from England. For the present year the issue will be vol. ii., part ii., of the "British Marine Annelids," by Prof. W. C. McIntosh, completing the Polychæta. Two volumes are in preparation for 1911, being vol. iv. of the "British Desmidiaceæ," by Mr. W. West and Prof. G. S. West, and vol. iii. of the "British Tunicata," containing the composite species and completing the work. This will complete Messrs. Alder and Hancock's works published by the society. Of other works in preparation, the first instalment of Dr. Malcolm Burr's "Earwigs of the World" will probably be the issue for 1912. An offer by the Rev. Hilderic Friend to contribute a work on the British earthworms has been accepted. Lord Avebury, F.R.S., was re-elected president of the society; Dr. S. F. Harmer, F.R.S., was elected a vice-president; Mr. F. DuCane Godman, F.R.S., was re-elected treasurer; and Mr. John Hopkinson was elected secretary.

THE death of Dr. A. E. Dolbear, for many years professor of physics at Tufts College, Massachusetts, removes one of the most remarkable of American thinkers and inventors. His inability to exploit his discoveries is alleged by his friends to be the only reason why his name is not more widely known. In addition to pioneer work on the telephone, wireless telegraphy, electric waves, and Röntgen rays, among inventions to be placed to his credit are a writing telegraph, a spring balance ammeter, an electric gyroscope to illustrate the rotation of the earth, and a new system of incandescent lighting. The most notable of his books was "Matter, Ether, and Motion." Prof. Dolbear was born at Norwich, Connecticut, in 1837. After serving as a "bound boy" on a New Hampshire farm, he worked successively in a ship-building yard and a printing office, studying geology, mineralogy, and astronomy in his scanty leisure. Later he "taught school" in Missouri, and worked in the U.S. armoury at Springfield. At the age of twenty-nine he entered the University of Michigan as a student of chemistry, and in six weeks became assistant instructor in that subject. The next year he was appointed an assistant professor in Kentucky University, and then professor of physics and chemistry at Bethany College, West Virginia. While holding the latter post he was three times elected Mayor of Bethany. His main career began in 1874, when the discovery of his scientific ability led to his being called to Tufts College.

A SUMMARY of gales recorded at anemograph stations in 1909 has just been issued by the Meteorological Office. Gales occurred in some part of the British Islands in every month of the year with the exception of June, but naturally gales occurred with far less frequency in the summer than during the winter. The most stormy months were January, October, and December. Strong gales, with a mean wind velocity of 47 or more miles an hour, force 9 of Beaufort notation, did not occur in May, June, or July. The absolute maximum velocity of wind in a gust was at the rate of 90 miles an hour, at Scilly on October 23, but the maximum velocity for an hour for this gale was only 70 miles. The next highest velocity in a gust was 78 miles, at Scilly on January 16, and this was followed, in order, by a gust of 76 miles an hour, at Southport on December 3. Gusts of 75 miles an hour occurred at Pendennis on November 18 and December 2, and at Scilly on December 2–3. No anemograph station had a higher wind velocity than 70 miles for an hour during the year. The summary gives the percentage of frequency of each unit of Beaufort notation at several stations grouped separately for the western and southern coasts combined, and for the eastern coasts and inland stations combined. It is comparatively exceptional at any station for winds of 8 and upwards of Beaufort notation to amount to 1 per cent. of all winds, and winds of gale force are less frequent in the eastern than in the western district.

DR. PENCK, the president of the Berlin Geographical Society, has rightly protested against the idea that there can be any objection to the expedition of any nation helping in Antarctic research on whatever route it may prefer to adopt. The unknown Antarctic area is so vast that any overlap and waste of effort would be deplorable, and the four Antarctic expeditions now being organised will probably be working in sufficiently distant fields to render any formal agreement unnecessary. The German expedition under Lieut. Filchner proposes to start from the Weddell Sea, which will also be used as the base of the American and Scottish expeditions. This part of Antarctica is still absolutely untrodden; the Scottish expedition under Dr. Bruce, which discovered Coats Land, was not able to land on it, and did not even see a convenient harbour. Ice navigation in the Weddell Sea is probably very difficult and uncertain, and Coats Land may be inaccessible in some seasons. The three-fold effort, by increasing the chances of success, is therefore to be welcomed, as at present this part of Antarctica is the most promising of important geographical results. If the three expeditions all establish their landing on this unknown coast, they will each find ample room for independent work.

INTEREST in the North Polar question has again been roused by the refusal of the Naval Committee of the United States House of Representatives to recommend any honour to Commander Peary until he has submitted proofs of his attainment of the Pole. As an expert committee appointed by the National Geographic Society of Washington, and consisting of three such competent authorities as Dr. H. Gannett, Admiral Chester, and Mr. O. H. Tittman, unanimously agreed that Peary reached the Pole, it may be felt that the Naval Committee might have accepted this verdict. The official committee of the House of Representatives is, however, hardly to be blamed for its caution in declining to recommend a Parliamentary honour until the official data have been published, or at least submitted to it. The scepticism felt by some authorities as to Peary's claim is based partly on his great acceleration after leaving his last white colleagues—his pace increasing from 9·6 miles to 26·4 miles a day on the journey north, and to 44 miles on the southward journey until he rejoined Captain Bartlett—and partly on the statement that he took noon observations at the Pole; at that date the apparent path of the sun, as seen from the North Pole, would have been so nearly horizontal that noon observations would have been practically impossible. The National Geographic Society of Washington has been most intimately connected with Peary, and might be prejudiced in his favour; but no such suspicion could be felt in regard to the committee it appointed. The report of that committee was, however, a brief statement of its conviction, and the materials on which its judgment was based are not yet available for public information. If Peary at his most northern point on April 6 was able to determine noon from the sun, he was probably some little distance south of the Pole. To determine the actual mathematical point of the Pole would be impossible during the hasty journey of a lightly equipped sledge party; but any slight error in the observations would not affect the conclusion adopted by most British geographers that Peary reached sufficiently near the Pole to justify his claim. It is to be hoped, however, that his full data will be soon published.

IN *Man* for February Mr. H. A. Rose describes various modes of establishing fictitious kinship now current in the Panjab. Such are the ties between people who have joined in the same pilgrimage; the *pâhul* or initiation rite of the Sikhs; the exchange of wristlets by youths, of turbans by men, and sheets by women; adoption by a patron to secure protection. These are important as illustrating the practices of adoption and succession, and they also throw light on the methods by which tribes grew under a process of accretion before the present rigid rules of exogamy and endogamy came to be established.

THE Botet collection of fossil mammals from the Pampa of Argentina, belonging to the city of Valencia, Spain, is one of the most important collections of its kind, but has not hitherto been exhaustively studied or described. It comprises, not only fine specimens of the ordinary ground-sloths and glyptodonts, Smilodon, and hoofed mammals, but also several new species and a remarkably well-preserved human skeleton. In view of its scientific interest, Prof. E. Boscá, of the University of Valencia, has arranged to prepare an illustrated descriptive catalogue of the collection, and, as a preliminary to this work, he is at present in London studying the original specimens described by Owen. After visiting the European museums Prof. Boscá will proceed to Argentina to examine the rich collections in Buenos Aires and La Plata.

ACCORDING to the second annual report, the demonstrations and lectures on natural history and economic subjects instituted by the Norwich Museum Association continue to meet with popular appreciation and support. The subjects of the 1908–9 course included the food of birds, flies as disease-disseminators, fungoid diseases of plants, Norfolk soils, and insect fruit-pests.

IN the February number of *Naturen* an anonymous correspondent describes two albino Norwegian lemmings, of which one is figured. Such albinos are stated to be extremely rare. In the same issue another writer contributes a notice of the capture by a trawler of the rare fish *Macrurus coelorhynchus*, a species first described in 1842, and of which very few examples have since been taken.

AT the close of an article in the February number of the *American Naturalist* on the question whether regeneration in animals exhibits a repetition of the ontogenetic and phylogenetic processes, Mr. Sergius Morgulis observes that "while the evidence shows that, as a rule, organs originate from similar germ-layers, both in ontogeny and in regeneration, there are also some striking exceptions to the rule. The hypothesis that the method of regeneration is causally influenced by the course of ontogeny is, therefore, quite unnecessary as a corollary. With the elimination of this hypothesis the conception of the atavistic nature of regenerated peculiarities, *i.e.* the conception of a repetition in regeneration of phylogenetic processes, loses its chief logical support. This last theory, however, is also objectionable, (1) because of its inherent inconsistency, (2) because it depends upon more or less problematic assumptions."

IN a paper entitled "Ungarnered Grain," published in the January number of the *Victorian Naturalist*, Dr. T. S. Hall directs attention to the need of further research into the natural history of Victoria. Sponges and protozoans, he points out, are still very imperfectly known, and much the same is the case with regard to crustaceans. Among fishes, it requires to be ascertained whether Galaxias spawns in fresh water, while no one appears to be able to produce definite evidence that the Australian eel breeds at great depths in the sea, or if, indeed, it journeys to the ocean at all. Further information is likewise required with regard to the breeding-habits of the native frogs, especially whether or no they require water during the metamorphosis.

To the February number of the *Zoologist* Colonel C. E. Shepherd communicates an account of the ear-bones of fishes, and more especially the one known as the asteriscus. Three pairs of these bones are developed, of which the sagitta is normally the largest, the asteriscus being the otolith found in the lagena of the sacculus, while the third bone is the lapillus. The form of the sagitta has long been known to be more or less constant and characteristic for the different family groups, and the author shows that the same holds good for the asteriscus, of which he claims to be the first to describe and illustrate the details in a number of species. Attention is specially directed to the great development of the asteriscus at the expense of the sagitta—which is reduced to a minute rod—in the members of the carp family. That this cannot be attributed to a fresh-water life is demonstrated by the fact that in the pike and perch the normal relative proportions of the sagitta and asteriscus are retained, and the reason for the special feature in the carp tribe has therefore still to be sought. As regards the functions of the otoliths, the author is inclined to support the theory that these include both hearing and the maintenance of the bodily equilibrium.

THE February issue of the Bulletin of the Sleeping Sickness Bureau (No. 14, vol. ii.) appears with cut edges, which will be found a great convenience by readers. It contains the usual useful *résumé* of papers dealing with trypanosomes and their agents of transmission, sleeping sickness, &c.

THE Bulletin of the Johns Hopkins Hospital for January (xxi., No. 226) contains two essays bearing on the history of medicine, one an address by Prof. Osler on Michael Servetus, who was done to death for heresy at Geneva in 1553, the other by Dr. Steiner on Dr. Lemuel Hopkins, a distinguished, though forgotten, American student of tuberculosis, who lived in the second half of the eighteenth century.

IN a paper dealing with the sewage-pollution of shell-fish (*Journal of Hygiene*, vol. ix., No. 4, 1909, p. 412) Mr. James Johnstone points out that at present no public authority possesses legal powers to deal with the question of the contamination of shell-fish. Polluted mussels supplied with clean sea-water undergo purification with rapid partial disappearance of the intestinal bacteria contained in their tissues—in four days, for instance, the number of contained bacteria had been reduced by about 93 per cent.

THE annual report for 1908 of the curator of the technological museums in Sydney has been received. Special reference is made to the collection of building and ornamental stones, in connection with which a brochure, containing coloured reproductions of specimens quarried in the colony of New South Wales, was issued. Notice is also given of a forthcoming volume on the "pines" of Australia, similar to the monograph on the Eucalypts, which will deal with the economics of Australian conifers.

THE action of light on the expansion of buds of woody plants is the subject of a paper contributed by Mr. V. Lubimenko to the *Bulletin de l'Académie Impériale des Sciences*, St. Petersburg (No. 2, 1910). Experiments were made with twigs placed under bell-jars covered with thicknesses of white or black paper. In certain cases a diminution of light retarded development, in others it accelerated it; but in all cases complete darkness caused a marked retardation in the expansion of the buds. The author advances the opinion that light is necessary for the internal chemical changes which precede growth.

THE report on the Botanic Station, Experimental Plots and Agricultural School, Dominica, has recently been issued, and shows that much useful work has been done in distributing among planters crops likely to prove of commercial value or possessing striking features from an ornamental point of view. Much attention has been devoted to the manuring, cultivation, and general management of cacao; the requirements of the lime industry have been investigated, and some preliminary work has been done on the planting of rubber.

IN view of the enormous increase in the number of publications devoted to insect pests, it is becoming more and more necessary to have occasional summaries of the work done in a particular subject. We are therefore pleased to see that a "Bibliography of Sugar-cane Entomology," drawn up by Mr. G. W. Kirkaldy, has been issued as Bulletin No. 8 of the Hawaiian Sugar-Planters' Association. The list of papers seems to be very complete; indeed, the author tells us that a considerable number of apparently worthless notes have been included because of the difficulty of drawing a sharp line between what is and what is not useful. The bulletin is divided into two parts: a list of work, arranged under authors, and a preliminary list of the insects, spiders, &c., of the sugar-cane fields, with cross-references to the papers in the first part in which they are mentioned.

A RECENT issue (No. 30) of the *Transvaal Agricultural Journal* contains an article on the olive, urging that more attention should be paid to this crop. The olive was introduced into Cape Colony many years ago, but for some reason or other has never become very popular. It does not bear a paying crop until it is at least six or seven years old, and the oil has to compete with highly adulterated commercial products; but there is a good deal of land in the Transvaal that would give satisfactory crops either with or without irrigation, and one or two trial plantations are already in existence which promise to be successful. We have also received from the Transvaal Department of Agriculture some Farmers' Bulletins dealing with sunflower cultivation, prickly pear for stock food, and the cultivation and preparation of the calabash pipe gourd. The sunflower does not appear to be a very promising crop, as it is expensive to handle and is largely produced in Russia.

PROF. DOVE, of Göttingen, contributes a suggestive article on the aims and methods of commercial geography to Petermann's *Mitteilungen*. The paper deals with the use of the population unit in discussion, the limits of effective capacity of trade routes, the relations of topography and climate to trade, and similar matters, and subjects some of the methods in ordinary use to somewhat severe criticism.

A NEW map showing the distribution of thunderstorm frequency in central and northern Europe, by Dr. E. Alt, appears in Petermann's *Mitteilungen*. The smallest yearly frequency occurs in Cornwall, north-western Scotland, Norway, and the Arctic coast, where the average is under five. The region of most frequent thunderstorms—more than thirty a year—appears in northern Italy and the Carpathians.

FROM a catalogue issued by Spindler and Hoyer, of Göttingen, we see that ninety-six seismographs, designed by Prof. Wiechert, have recently been distributed in various parts of the world. One has been installed by the National Physical Laboratory at Eskdalemuir. The largest of these instruments carries a mass of 17,000 kilos., and the motion of the ground relatively to this is magnified 2200 times. There is, however, a 5 per cent. loss in consequence of the inertia and elasticity of the system of levers. The instrument costs 5000 marks.

BETWEEN July 1 and December 31, 1909, at Shide, in the Isle of Wight, 279 earthquakes were recorded. Each of these records is confirmed by corresponding observations at other observatories, whilst many of them are known to be the surviving efforts of earthquakes which were large at a distant origin. They are therefore of great importance. The instruments at Shide are of the type adopted by the British Association, recording on paper moving at a rate of 4 mm. per minute. During the same interval of time Hamburg recorded 123 shocks, Strassburg 64, and Laibach 42. These great differences in the number of records obtained at different stations appear to be almost entirely due to the type of instrument employed. Those which record on smoked paper are excellent for large disturbances, but fail to record movements which are small.

FROM Dr. Fielding H. Garrison we have received reprints of articles on "Josiah Willard Gibbs and his Relation to Modern Science" and "Physiology and the Second Law of Thermodynamics," which have appeared in the *Popular Science Monthly*, May–August, 1909, and the *New York Medical Journal* for September 25, 1909. The author is assistant librarian to the Army Medical Library at Washington. His writings, notably the one on Willard Gibbs, afford a lucid exposition of the principles of thermodynamics based on an intimate study of the large mass of literature which has centred round this important branch of physics. Most conspicuous, too, is Dr. Garrison's clear appreciation of the debt which experimental science owes to the late Prof. Gibbs for original work essentially mathematical in character. What mathematics can and must do for science, and, on the other hand, what it should never try to do, are points often ill understood, even by workers on physical science that have been trained on orthodox academic lines, and few people have presented the case so effectively as has been done by the army doctor who has written these papers.

A SERIES of experiments have been made recently at the Bureau of Standards at Washington to determine the proper source of light to combine with the mercury arc to produce the best imitation of average daylight, and the results are embodied in a paper by Mr. H. E. Ives in the November (1909) number of the Bulletin. It appears that of the ordinary lights, the Welsbach mantle, the carbon, the tungsten, and the tantalum filament glow lamps are all nearly complementary in colour to the mercury lamp, and have, therefore, only to be combined with the latter in suitable proportions to produce satisfactory imitations of daylight. The best proportions are 1 candle-power of mercury light to 0·57 candle-power of Welsbach light, 0·54 of tungsten, or 0·50 of carbon glow light. The watts per candle-power required are 0·80 for the tungsten and 1·4 for the carbon filament combinations respectively. Although the Welsbach cannot be compared in this way, the author finds from the cost of running that the Welsbach mercury combination compares closely with the tungsten mercury one in efficiency.

THE *Journal de Physique* for February contains a communication, made to the Société française de Physique by M. Charles Lallemand, on tides in the earth's crust (see NATURE, October 14, p. 457). After a description of the double horizontal pendulum of Hecker, the author explains how the diurnal tilting of the crust, due to the heating of the tropics, may be separated from the smaller semi-diurnal tilt due to the solar tide, and gives diagrams showing the extent of each as determined at Potsdam. The first has a semi-amplitude of the order 10–20 thousandths of a second of arc, the second 2–6 thousandths. Further investigation allows the lunar tide to be determined, and this is found to have a semi-amplitude of the order 10 thousandths. It is hoped by the help of still more sensitive apparatus to detect the half-monthly tide, which should have a semi-amplitude about half that of the semi-diurnal solar tide.

THE Bausch and Lomb Optical Co., 19 Thavies Inn, E.C., has afforded an opportunity to a representative of NATURE to examine the Balopticon lanterns which it has just produced and see a demonstration of their functions. The lanterns are designed for transparent or opaque projection, and they combine neatness with efficiency. The arc-lamps are of special design and of small dimensions, and the bodies of the lanterns are designed to suit the lamps, so that the lanterns, as a whole, are delightfully compact. The lamp-case is lined with asbestos, and the top has the form of a light-tight ventilator, securing a minimum heating effect during operation. The ventilating arrangement is really very satisfactory, and the whole mechanical construction is commendable. The lantern suffers, however, from the merits of its qualities, inasmuch as an ordinary arc-lamp cannot be used with it. Notwithstanding this, the Balopticon, which is made in various models, provides, at a reasonable price, a projection apparatus which is well designed and should be extensively used. An instructive pamphlet referring to the Balopticon lanterns is issued by the Bausch and Lomb Optical Co.

THE first volume in celebration of the jubilee of Prof. Arrhenius was noticed in NATURE of February 3. The second volume (*Zeitschrift für physikalische Chemie*, Band 70) has now been issued. It contains forty-five papers by chemists of every nationality. The attention of both supporters and opponents of Arrhenius's theory of electrolytic dissociation may be directed to the article by Mr. G. N. Lewis "On the Use and Abuse of the Ionic Theory."

VARIOUS articles of glassware for laboratory use, including beakers, retorts, boiling, Erlenmeyer, and Kjeldahl flasks, have been forwarded for inspection by Messrs. John J. Griffin and Sons, Ltd., of Kingsway, London, W.C. They are made from a new variety of laboratory glass now being produced by the Rhenish Glass Works, Cologne-Ehrenfeld. This glass is said to be equal to Jena ware as regards resistance to the action of water and of various chemical reagents, whilst having an appreciable advantage in price. The apparatus submitted, though perhaps a little heavier than usual, is well made, and satisfactory in lustre and general appearance. Its refractoriness towards the action of water, acids, and alkalies could, of course, only be proved by trial, but in this respect the behaviour of the glass is attested by certificates quoted, including one from the Physikalisch-Technische Reichsanstalt at Charlottenburg. After a preliminary treatment of the articles for three days, water at 18° C. acting during seven days extracted only 0·002 milligram of alkali (Na_2O) from each 100 sq. cm. of surface exposed, and in three hours at 80° only 0·009 milligram was removed. The material is therefore classed as "water-resisting" glass. Other tests adduced show the extent of the action exerted by boiling solutions of sulphuric acid, sodium carbonate, and sodium hydroxide upon the glass during specified periods, and also the effects of sudden change of temperature. The results go to show that the new glass is a very satisfactory material for chemical apparatus.

IN addition to the books referred to in "Forthcoming Books of Science" (NATURE, March 10), the following works are announced:—"Tomatoes and How to Grow Them," F. R. Castle; "Mushrooms and their Cultivation," T. W. Sanders; "Bees for Profit and Pleasure," H. Geary; "Window and Indoor Gardening," T. W. Sanders (*Collingridge*); "A Book about Sweet Peas," W. P. Wright; "Garden Guide," W. P. Wright (*Headley*); "Radio-chemistry," A. T. Cameron (*Dent*); "The History of Chemistry," vol. ii., Sir Edward Thorpe, C.B., F.R.S.; "Last Words on Evolution," E. Haeckel; "The Evolution of Man," E. Haeckel, translated by J. McCabe, 2 vols., new edition; "The Story of Creation," E. Clodd, new edition (*Watts*); "A Text-book of Nervous Diseases," Drs. W. A. Turner and T. G. Stewart; "The Practice of Surgery," W. G. Spencer and G. E. Gask; "The Malarial Fevers, Hæmoglobinuric Fever, and the Blood Protozoa of Man," Captain C. F. Craig (*Churchill*).

OUR ASTRONOMICAL COLUMN.

COMET 1910*a*.—A number of observations, with drawings and photographs, of comet 1910*a* are published in the March number of the *Bulletin de la Société astronomique de France*. Among others, M. Quénisset describes the observations made at the Juvisy Observatory, where photographs of the comet and its spectrum were taken, and drawings made, between January 21 and February 12.

A photograph taken on January 29 shows the secondary tail extending to some distance from the nucleus on the south side of the main tail, with which it formed an angle of about 25°; on this date the main tail was estimated to be longer than 62 million miles. The fan-shaped extension towards the sun is also shown, and extended to some 8′ from the nucleus, its northern edge showing the concave form discussed by M. Sola.

Comte de la Baume Pluvinel reports that the spectrograms show the nucleus sharply defined in the two principal radiations of the cyanogen band at λ 388, and an intense image of the comet was produced in the hydrocarbon band near λ 472. Between these, the nucleus and tail give a continuous spectrum which presents several condensations, the interpretation of which is still under investigation.

The observations made at the Lick Observatory are recorded in Bulletin No. 174, and show that considerable changes took place in the spectrum between January 19 and 31. The comet was first seen on January 19 as a fan-shaped cloud several times as bright as Venus at its maximum brilliancy, and spectroscopic observations showed the D lines bright, against a background of sky spectrum; D_2 was seen to be much stronger, and to extend further than D_1. The comet, having considerably decreased in brightness, could not be seen the next day, and a great storm prevented further observations until January 26. It was then seen that, in addition to the D lines, the regular cometary bands were present. On January 27 the same features were recorded, and an additional brightening was seen just to the right of D. A photograph of the spectrum showed a great similarity to the spectrum of comet 1907*d*, as photographed by Dr. Campbell, the continuous spectrum being relatively weak as compared with the bands. Observations made on January 31 showed that the D lines and the red condensation had disappeared, and that the spectrum of the tail was continuous, extending to a distance of 1° from the head.

On February 1 and 2 spectra were photographed with a prismatic camera, and show that the light of the tail is practically all within the visual region, extending towards the violet but a short distance beyond λ 467. Dr. Wright suggests that it may be due to sodium vapour rendered fluorescent by the intense sunlight; this assumption might also account for the faint band seen on the red side of the D lines.

Dr. Albrecht also made spectroscopic observations with a newly designed grating spectrograph of high dispersion attached to the 36-inch refractor. The resulting photographs, on January 27, show the D lines, D_1 being not more than one-third the intensity of D_2. The light from a sodium flame was employed as a comparison spectrum, and measures made of the radial velocity of the comet, which was found to be +66·1 km., and is believed to be trustworthy within 2 or 3 km. Dr. Albrecht suggests that such observations might be useful in determining the orbit of a comet in rare cases, such as the present, when it is difficult to determine accurate positions. Subsequent observations showed that between January 27 and 30 the intensity of the D lines must have decreased ten-fold.

Photographs taken by Messrs. Merrill and Oliver cover the period January 26 to February 1, and show the general changes and details well, but no sharp narrow streamers and bright knots or condensations are anywhere indicated.

In No. 610 of the *Astronomical Journal* Prof. Barnard reports that cloudy weather prevented photographs being taken at the Yerkes Observatory during the period of the comet's greatest brilliancy, except on January 21 and 24, when fair negatives were obtained. A photograph taken on February 3 shows the extension beyond the head, towards the sun, to be 12′ long. This extension is a prolongation of the southern edge of the main tail, and is shown on all three photographs taken on that date.

A further continuation of Dr. Kobold's ephemeris is given in No. 4393 of the *Astronomische Nachrichten*, and shows that the comet is still moving very slowly northwards through Pegasus, the position for March 17 being 22h. 27·6m., +16° 32′. An observation made by Herr Pechüle on March 6 gave corrections of 0s., +0·5′, and showed the magnitude to be about 9·5.

HALLEY'S COMET.—Numerous photographs of Halley's comet have been secured, at the Lick Observatory, with the Crossley reflector and other instruments. The negatives taken on December 11, 12, and 13, 1909, show the coma and faint traces of a cone-shaped tail; as the angle made by lines from the comet to the earth and sun, respectively, was, on that date, less than 2°, this indicates a fairly well-developed tail. A photograph secured by Mr. Olivier with the Crocker telescope on January 28 shows a tail nearly 1° long. On a negative taken with the Crossley reflector on February 4 a very fine, sharp, stellar nucleus, less than 5″ in diameter, is seen, and the tail appears as a narrow, sharply defined cone; but similar photographs secured on February 10 and 11 show an entirely different form of tail, the narrow quiescent cone having given way to a tail having several fine streamers radiating from the head; the two longest streamers are straight, and can be traced to a distance of 20′ from the head, while the most southerly one is curved. These changes are also shown on the photographs taken with other instruments, where the tail can be traced to a distance of 40′, and doubtless indicate a sudden burst of activity during the first week in February (Lick Observatory Bulletin, No. 174, p. 183).

PIDOUX'S COMET.—It now appears probable that the report of the discovery of a new comet at Geneva was a mistake. A plate exposed through clouds on February 20 showed a V-shaped nebulous form near Halley's comet, and before the identification of this object could be completed, the news arrived that a new comet, in the same position, had been discovered at Cardiff. A plate exposed on February 14, on the same region, showed no trace of the object, but a similar form was seen on the edge of a plate taken on February 16; but on a photograph taken at Heidelberg on February 10, which covers the region where, according to calculation, the alleged comet should then have appeared, there is no trace of any such object. As no control plate is available, the existence of the reported comet cannot be confirmed (*Astronomische Nachrichten*, No. 4392).

THE INTERNATIONAL AËRO AND MOTOR BOAT EXHIBITION.

THIS exhibition opened at Olympia on March 11, and will continue until March 19. The Society of Motor Manufacturers and Traders, Ltd., supported by the Aëro Club of the United Kingdom, are responsible for the organisation, and deserve commendation for the fine collection of machines on show. It will be remembered that the first exhibition of this kind, organised by the same society, was held last March. Great advances have been made in flying machines during the interval, and the fact that British makers do not intend to be left behind will be evident to anyone who visits Olympia this week. A pleasing feature of the present exhibition is the almost entire absence of "crank" ideas, especially in the full-size machines shown. Such are almost inevitable in any collection of models, but even the model section contains many fine examples of thoughtful design and skilful workmanship.

Monoplanes comprise by far the larger number of machines in the exhibition. Apart from any inherent advantages of this design, such as space occupied, convenience in dismounting and packing for transit, and lightness, there is no doubt that its popularity, both with makers and buyers, is owing to Blériot's flight across the Channel last summer. There are twenty monoplanes, nine biplanes, and one triplane, all of these being full-size machines. In addition, there are two balloons, a dirigible, and a large number of engines and accessories shown separately, as well as motor-boats and launches. In practically every case it is evident that the brains of a skilled engineer have been brought to bear on the design and construction.

Profiting by past experience in metal propellers and their dangers, most of the propellers shown are constructed of wood, built up so as to secure the grain everywhere running straight from tip to tip. A few makers are bracing the lattice girder forming the main frame in the monoplane type with wood in preference to piano wire, although the use of the latter for bracing is still general. In several cases piano wire has been abandoned for bracing the wings, the preferable material for this purpose being light stranded wire rope and flat steel ribbon.

The engines are generally of the fixed cylinder type, although a few rotary engines may be observed. Water-cooling is more usual than air-cooling. In biplanes the engine and propeller are usually situated behind the pilot; in monoplanes these are generally in front of the seat, although in the case of the Petre monoplane the propeller is at the extreme rear of the machine, and is driven by a tubular shaft from the engine which is placed behind the pilot; but few makers warp or alter the inclination of the main wings for steering or for stability; in most cases ailerons are fitted to biplanes, and in the monoplane type the tails are made movable for vertical and horizontal control. Practically all wings are double surfaced. More firms are paying attention to the matter of reducing the number of levers required for control. For example, in the Humber machines all control is effected by a single steering wheel mounted on a pillar which can swing, and the steering-wheel spindle is capable of axial as well as rotary motion in the pillar. These movements independently operate all the control; there are no foot or hand levers.

It is exceedingly gratifying to notice the large number of British-built aëroplanes; some sixteen of the total machines on show have been built entirely in this country; of the engines shown separately, by far the greater number are British-built. There is no doubt that a great awakening to the possibilities has taken place among our engineers, and that no efforts have been spared during the past autumn and winter to develop the manufacture of flying machines. Many of these British machines have been tested, and when we possess, as no doubt we shall before the coming summer is over, a reasonable number of British pilots having experience with the machines, we shall be able to regard this country as no longer behind in this important industry. The limitations of space forbid us noticing particularly any but a very few of the machines in the exhibition.

Of machines shown by members of the Royal Aëro Club, one of the most interesting is a Short Wright biplane, the first of its kind built in England, and belonging to the Hon. C. S. Rolls. This machine has flown about 100 miles, and has won many prizes. In general design it closely resembles the machines used by the Wright Brothers. There are twin screws, chain driven; the dimensions are 40 feet by 28 feet by 8 feet. Another Short biplane is shown belonging to Mr. J. T. C. Moore-Brabazon. This machine measures 45 feet in breadth, 28 feet in length, and 8½ feet in height. The weight of machine complete, with aviator and in flying order, is 1500 lb.; the actual lifting surface is 450 square feet. The machine is fitted with Short's patent front elevators and balancing planes, and has their system of trussed girder skids. Twin propellers are fitted running in the same direction; this is the first time this principle has been adopted, and has proved to be very successful. A front vertical rudder has been substituted for one in the rear for directional steering. The speed is about 48 miles per hour, and the machine has made a large number of flights, that of March 1, 1910, being of 32 minutes' duration in covering a distance of about 25 miles. This machine won the 1000*l.* prize (*Daily Mail*) for the circular mile, all-British made. A monoplane built by Messrs. Holland and Holland, and belonging to Mr. B. Nicolson, is also shown.

Messrs. Short Bros. also show a new biplane built for the Hon. C. S. Rolls. The engine is a Green four-cylinder, 105 mm. by 120 mm. bore, giving 38 horse-power at 1200 revolutions per minute. The lifting surface is 270 square feet, and the weight complete is 700 lb. In the annexe is a Sommer biplane, also owned by the Hon. C. S. Rolls. This machine is fitted with a Gnome engine (rotary). Messrs. Humber, of Coventry, show three monoplanes of their own manufacture. The workmanship and finish of these machines are beyond reproach. Messrs. A. V. Roe and Co. are represented by a triplane of all-British make. This machine is 20 feet long by 20 feet span, and is 9 feet high. The main planes, and also the tail, consist of three planes arranged one over the other, the total supporting surface being 320 square feet. The weight without motor and fittings is 150 lb. All the planes are under control, so that the angle of attack can be adjusted from the steering wheel, and the main planes can be warped. The seats for the pilot and one passenger are behind the main planes, and the engine and propeller in front. Machines of this type have made frequent flights with a motor of 9 horse-power only, and start quickly, often in twenty yards.

Messrs. Blériot have three of their models No. XI. cross-Channel type of monoplane in the exhibition. These machines are fitted with a three-cylinder Anzani motor giving about 25 horse-power; bore, 105 mm.; stroke, 130 mm.; weight in full running trim, 60 kilograms. The propeller is made of layers of French walnut, of diameter 2·1 metres, and weighs 4½ kilograms only; its speed is from 1200 to 1700 revolutions per minute. The monoplane measures about 25½ feet across the wings, and is about 26 feet long; the sustaining surface is about 14 square metres. The total weight of the machine is about 300 kilograms, including the pilot and fuel for a two-hours' run. The speed is about 68 kilometres per hour, and the machine can lift and sustain in flight about 22 kilograms per square metre of supporting surface, *i.e.* about 5 lb. per square foot.

Messrs. A. Darracq and Co. show the latest type of Farman biplane. The length is 39 feet, span 32½ feet, height 11 feet 4 inches. The supporting surface is 480 square feet, and the weight without engine is 1050 lb. A Chauvière propeller 8½ feet in diameter is placed at the rear of the main planes. The motor on the machine shown is a 50 horse-power Darracq four-cylinder horizontally opposed; bore, 130 mm.; stroke, 120 mm. The cylinders are water-cooled, and the weight, with oil and water pumps and carburettor, is 242 lb. The machines are made under the personal supervision of Mr. Henry Farman at the Châlons Camp, in France.

The Demoiselle machine of Mr. Santos-Dumont shown at the Clement-Bayard stand attracted great attention. This is claimed to be the smallest, lightest, and fastest aëroplane in the world. The length is about 20 feet, width about 18 feet, supporting surface 110 square feet, weight 242 lb. with a two-cylinder water-cooled motor. The radiators are arranged close up under the wings, one on each side of the main frame. The horizontal and vertical planes forming the tail are rigid as regards one another, but the tail can turn as a whole on vertical and horizontal axes for controlling directional and elevating steering. Another interesting exhibit at this stand is the engineer's cab of the dirigible Clement-Bayard. We noted in the engines shown at this stand the care which had been taken to lock all nuts and fastenings so as to prevent them becoming loose.

A Grégoire Gyp monoplane shown by the Fiat Motors, Ltd., did not arrive until ten o'clock on Friday evening. It is interesting to know that the machine was ready for exhibition shortly after eleven o'clock on the same night, showing the ease with which the monoplane type can be erected. The Phœnix Radial Rotary Motor Co., Ltd., show part of a twelve-cylinder rotary engine under construction for Mr. Cody.

The Motor Supply Co., Ltd., show an Avis type monoplane built by the Scottish Aëroplane Syndicate of London. This machine is entirely of British make, except the 30 horse-power Anzani engine. The machine is of the non-lifting tail type, 27 feet wide and 27 feet long. The main planes have a surface of 160 square feet. The weight without motor is 280 lb.; the weight of the motor complete is 150 lb. Messrs. Mulliner, of Long Acre, show a monoplane of entirely British make. This machine has an improved system of warping the trailing edge, combined with the action of a non-lifting type of elevator and a rudder at the rear. Messrs. Mann and Overtons, Ltd., of Pimlico, show a monoplane of the Santos-Dumont type. An English-built monoplane is shown by Messrs. R. Lascelles and Co., Ltd., and an all-British biplane by

Messrs. George and Jobling; both these machines possess interesting features in the matter of control. There are also monoplanes by the Star Engineering Co., Ltd., of Wolverhampton, and by Handley Page, Ltd., of London.

It is quite impossible to deal adequately with all the points of interest in the exhibition. That its success is assured, and that its effects will be far-reaching, are evidenced by the large numbers of visitors, most of whom appeared to be keenly interested and full of inquiries.

EXPLORATIONS IN THE GLACIER TRIBUTARIES OF THE SHAYOK RIVER, KASHMIR TERRITORY.

IN the *Times* of December 21, 1909, reference was made to certain discoveries by a party consisting of Dr. E. G. Longstaff, Dr. A. Neve, and Lieut. A. M. Slingsby in the Kashmir Himalaya. The *Geographical Journal* of November, 1909, also had an article, based upon an account of the tour, written by Dr. Neve in the *Times of India* of September 4. A few remarks concerning the addition to Himalayan geography referred to in these communications may be of interest.

The topography of this part of Baltistan requires explanation; if the atlas sheets are examined, it will be seen how very few trigonometrical points are to be found east of longitude 77°. They are much fewer than in the portion of Baltistan I had to survey on the Lower Shayok and Indus, and the branches of the Shigar tributary of the latter river. The difficulties of penetrating into these out-of-the-way valleys were very great, and it was almost a superhuman task for Mr. Ryall and other assistants to produce, in the limited time given them, a better or more accurate idea of its geographical features. Very few of the glaciers were followed up, or can be followed up, so their sources were merely sketched in by eye from a distance. Very many tributaries are inaccessible, either from their rocky, wall-like sides, or the stream being too deep and rapid to ford, there being no bridges, or the means of making them. Thus the topography can only be classed as rough reconnaissance. The Saichar valley and its glacier was not ascended far, if at all, and even the distance and size Mr. Ryall assigned to it some twelve miles N.W. from Saichar would in nature appear to be its total length; it probably has a bend, and if straight a distant ice fall, or a local narrowing might give the appearance of a watershed. I have not heard of Mr. Ryall for very many years; if he is still living he would be able to tell us whether he ascended the glacier to any distance. His field book, if it is to be found, would give much information as to where he went. There would be his boiling-point observations, and the notes he made in it.

There can be no absolute accuracy in the topography at the head of the Kondus Valley, south-east of Snowy Peak K. This valley, I would point out, is well worthy of further exploration, because it is possible some high point on its eastern side could be reached from which a view would be obtained of the higher portion of the newly-discovered Terim Glacier and the snowy range which bounds it on the north-eastward. Concerning the Terim Glacier extension of the Saichar, the discovery alters the position of the main range, which may be taken as fairly well laid down up to lat. 25° 30′, long. 77° 30′. North of lat. 35° 30′ up to about lat. 35° 45′ and long. 77° has certainly to be mapped. This is some forty-five to fifty miles in length, and lies fifteen miles or more further to the north and eastward. It is to be hoped that Colonel Long, the present Surveyor-General of India, will see his way to depute one or two of his best officers to extend the triangulation, fix more points, and accurately lay down this corner on a plane table—an attractive, delightful summer's work for someone.

That very high peaks in this corner, lying to the east of K2 and Gusherbrum, escaped the view of the triangulators when they were observing at the principal stations of the Indus River and Changchenmo series is not surprising. The high mass between the head of the Nubra River and the Shayok, 20,000 to 22,000 feet, would hide much. From trigonometrical stations east of Leh, the same portion of the main water parting is shut out by another lofty mass 22,000 to 25,000 feet, dominating the Shayok Valley on its northern side.

The Shayok series was a very short one, the stations of observation did not extend to lat. 35°, and from the two highest stations, Ajanliung, 19,903 feet, and Telthep, 19,705 feet, overlooking and south of the Shayok Valley, peaks at the head of the Saichar Glacier would not be visible owing to the intervening mountain masses.

A point of interest is the great length of the Terim Glacier, estimated at forty-four miles, next its position and direction, in connection with the trend of the ranges in Ladak and the mountain area both to the eastward and westward. This great glacier, as described, would appear to occupy a blank on the map, and, like a piece of a puzzle, exactly where it might be expected to fit in. This the topography at the head of the Saichar Glacier and the line of the main water parting did not previously indicate on the atlas sheet.

A valuable compilation was published in 1907, viz. "A Sketch of the Geography and Geology of the Himalaya Mountains and Thibet," by Colonel S. G. Burrard, R.E., F.R.S., superintendent Trigonometrical Survey, and H. H. Hayden, superintendent Geological Survey of India. In 1883—presidential address, Geographical Section, British Association—I made an attempt to bring the remarkable parallelism of the mountain ranges into some sort of systematic sequence from the plains up to the loftiest parts of the Himalayan chain. Correctness in detail was not to be expected over such an extended area, yet it is some satisfaction to find the general principle underlying my plans and sections has been accepted by officers of the Trigonometrical and Geological Surveys. My Shayok Kailas range they call the Kailas; for my Mustakh axis, which I considered one of the most important, they adopt that of Karakoram; but I am now inclined to think, from what Dr. Longstaff reports, that yet another well-marked elevated range is indicated by an extension of Younghusband's Aghils, on the northern side of the Oprang Valley, continued to Longstaff's new peak, 27,610 feet, about long. 77° and lat. 35° 30′ (*vide Geographical Journal*, January, 1910, p. 65). I am doubtful if this assigned position is correct, for on the atlas sheet it is close to the head of the glacier called Sherpi Gang, in the Kondus Valley. The position long. 77° 20′ and lat. 35° 40′ given in the *Times of India* would appear to fit in best with the general account. The Karakoram pass and watershed lie some forty miles to the north-east of the Saichar Glacier, and must therefore fall on a still more northern axis of elevation, running in the direction of the Lingzhithang plain, and quite distinct from my Mustakh one.

From Leh the direction of the Ladak axis or range is indisputably to the south-east, and it leaves the Pangkong Lake and Rudok well to the north, but the west and east wrinkling exhibited in the ranges much further to the north has not been so definitely established owing to the absence at many points of geological data to link them up; this is particularly the case with the Karakoram pass and the country north of the Changchenmo range.

The topography of this area leads me to notice what is written in the above-mentioned work by Colonel Burrard and Dr. Hayden, part ii., p. 100:—"Even the great Karakoram peaks themselves seem to follow two alignments. The Masherbrum peaks and peak 63 or K12 (table v. of part i.) surmount a ridge parallel to that on which the peaks of K2 and Gusherbrum stand, and at a distance of ten miles from it." This feature can thus be explained.

The Masherbrum ridge westward from K6, 25,119 feet, the peak which the Duke of the Abruzzi ascended to 24,583 feet last summer, represents, together with the Mustakh Pass granite axis, one main broad line of elevation. The Baltoro Valley occupies the trough scoured by its glacier along the strike and junction of the stratified rocks of the Masherbrum side, which originally lay up against the granite, and may very possibly have been once continuous over it. The southern Masherbrum ridge is, in fact, only a secondary feature, the result of denudation.

I cannot say for certain what K2 is composed of—probably not granite, more likely of the metamorphic and stratified series coming in on the north of the axis. This may be explained in more detail.

The stratified rocks, schists and slates, limestones and sandstones, a series of enormous thickness, composing the

Panjal and Zanskar systems, occupy, as it were, ellipsoid basins or long troughs in the granite, and crushed up against it. Lines of drainage often follow the line of junction, breaking through the basal granitoid rock at certain points. We find a very instructive section on the Panmah Glacier, further west, which has cut its way down through the main granite axis, having here a breadth of ten miles or so. Further up the glacier, at Drenmung, where it bends round to the north-west, this main source, the Nobundi Sobundi Glacier, lies parallel to the line of the main water parting between the Indus drainage and the Oprang Valley. The broad river of ice is bounded on the south-west by the granite, on the north-east by a great series of stratified rocks forming the elevated main range for many miles and dipping to the northward. The breadth of granite continues thence for fifteen miles south-east, and then another twenty-five miles east towards Gusherbrum, and comes in, in the Baltoro Valley, forming the wonderful spurs and peaks of its northern side. Across the breadth of the glacier, moraine after moraine, for some three miles, the precipitous southern flank of the Masherbrum Ridge rises, all of stratified rocks, and Gusherbrum, at the eastern end, appeared to be of the same series, but closer to their junction with the granite, and vertical.

At Gusherbrum, K6 and K, a slight change in the strike of the whole mountain mass takes place. The head of the Terim Glacier, according to Dr. Longstaff, extends up to Gusherbrum, and he has proved that this glacier is the head of Ryall's Saichar Glacier, which, so far as it is shown on the atlas sheet, has a direction N.W. to S.E., the line of valley trough being continued eastward in the Nubra to the junction of that river with the Shayok. There seems a probability, arising from the interesting fact mentioned by Dr. Neve of granite rocks on the south of the Terim Glacier, stratified rocks on the north, that the former correspond to those north of the Baltoro Valley, and that the stratified series from near Gusherbrum continues east and forms the water parting between the Oprang Valley and the Terim Glacier. If such be the case we have a continuous strike of granite along the Nubra River to Changlung, *vide* Lydekker's map, Memoirs of the Geological Survey, vol. xxii., thence to the Marse mik La, which I know, to Nyak Tso of the Pangkong, and so on towards the Aling Kangri range, leading into Dr. Sven Hedin's Trans-Himalaya.

To return to the Masherbrum ridge, this finds its counterpart further west, and is represented by those remarkable sharp-pointed peaks, No. 11, B16, and B15, on the east side of the Biafo Glacier. This great glacier and the Hisper, indicating the position of this Mustakh axis as far as Hunza Nagayr, is truly one of the most striking physical features to be met with in the Himalayan chain.

H. H. GODWIN-AUSTEN.

BOTANICAL PAPERS FROM CAMBRIDGE.[1]

THE six papers referred to below are the work of members of the vigorous school of botany (including palæobotany) which now flourishes at Cambridge.

(1) Miss Stephens's investigation, begun in the botanical laboratory of the South African College at the suggestion of Prof. Pearson, is of considerable importance. The Penæaceæ are a small order of heath-like shrubs, allied to the Daphne family, and limited to the south-western region of Cape Colony. Out of the five genera, three, represented by six species, have been examined, and have all been found to agree in the essential points.

The ovary has four carpels and four loculi, each of which contains from two to four anatropous ovules with two integuments. The embryo-sac is derived directly, without intermediate cell-formation, from its mother cell; hence the reduction-division takes place in the nucleus of the embryo-sac. Four nuclei are first formed, and then each of these divides into two. The four pairs of nuclei are usually found lying cross-wise, one pair at each end of the sac and the other two at the sides. Each pair then divides again; four free nuclei, one from each group, fuse to form the primary endosperm-nucleus, while the three remaining cells in the four groups assume more or less the arrangement and appearance of an egg-apparatus. Thus the mature embryo-sac normally contains four peripheral groups of cells, each group resembling an egg-apparatus, and four nuclei in the middle, fusing to form the endosperm-nucleus; occasional variations from the prevailing arrangement were observed. Usually it is the ovum belonging to the group nearest the micropyle which is fertilised. In the case of this apical group fertilisation has been repeatedly observed; there is no evidence that parthenogenesis occurs. The interesting question whether the quadruple endosperm nucleus is fertilised, as in typical angiosperms, by one of the male nuclei, has not yet been determined. The embryo is remarkable for the absence of a suspensor, the small development of the cotyledons in comparison with the bulky hypocotyl, and the absence of a root-cap up to the time when the seed is ripe.

The significance of the peculiar type of embryo-sac in this order (only paralleled, as yet, by a species of Euphorbia) is fully discussed. The interest of the question is enhanced by the consideration that the Penæaceæ appear to be a dying-out family, as suggested by their limited distribution, the non-germination of the seeds in culture, and the extreme rarity of seedlings in nature. The author sums up her conclusions as follows:—"This embryo-sac is probably to be regarded as a derived form, with all four megaspores included in its development, rather than as a primitive one. . . ." "It is suggested that in either case its endosperm is formed, like that of *Welwitschia*, by a fusion of potential gametes, all the nuclei in the sac being looked upon as potential or reduced gametes."

(2) The genus Saxegothæa is represented by a single species, a small, yew-like tree growing in wet woods on the upper slopes of the Chilian Andes. Mr. Stiles has made a detailed investigation of the anatomy of both vegetative and reproductive organs, and confirms the position usually assigned to the genus as a member of the Podocarpeæ, a tribe of taxoid conifers. At the same time, he finds many points in common between Saxegothæa and the Araucarieæ. He unnecessarily weakens his case by the statement that "Saxegothæa differs from the Araucarieæ in having the ovule inverted" (p. 218); the ovule is, of course, inverted in both groups alike.

The author concludes:—"Thus it would seem probable, as Lindley said in his first description of the plant [1851], that Saxegothæa is a transition of a remarkable kind between the Pinaceæ and the Taxaceæ." The conclusion is interesting, as it supports the view that the Coniferales are essentially a monophyletic stock.

(3) The authors, Messrs. South and Compton, were so fortunate as to have at their disposal a plant of the Mexican cycad, *Dioon edule*, no less than 120 years old; it had spent thirty years of its life in the Botanic Garden at Manchester. In so old a plant—65 cm. in height and 80 cm. in girth—the narrowness of the vascular zone was remarkable; it was only ½ cm. in thickness, one-fifteenth of the radius of the stem; this poor development of the conducting system is accounted for by the small number of leaves functional at one time, the slow rate of growth, and the xerophilous habit. The structure of the stem is normal as in Stangeria, showing none of the vascular anomalies characteristic of some other cycadaceous genera. Within the stem two dome-like systems of internal strands, running out into the withered peduncles of bygone cones, were observed. The authors accept Count Solms-Laubach's interpretation that the growth of the stem is sympodial; each cone terminates the main axis, while the stem is continued by one of a pair of opposite buds. The presence of *two* such buds (one being abortive) is a new

[1] (1) The Embryo-sac and Embryo of certain Penæaceæ. By E. L. Stephens. (*Annals of Botany*, vol. xxiii., pp. 363–78; pl. xxv. and xxvi., July, 1909.)

(2) The Anatomy of *Saxegothaea conspicua*, Lindl. By W. Stiles. (*New Phytologist*, vol. vii., pp. 209–22; figs. 28–34, November, 1908.)

(3) Notes on the Anatomy of *Dioon edule*, Lindl. By F. W. South and R. H. Compton. (*Ibid.*, pp. 222–29; figs. 35–40, November, 1908.)

(4) On a Cone of *Calamostachys Binneyana*, Carruthers, attached to a Leafy Shoot. By H. Hamshaw Thomas. (*Ibid.*, vol. viii., pp. 249–60; pl. i. and figs. 31, 32, July, 1909.)

(5) The Morphology and Anatomy of *Utricularia brachiata*, Oliver. By R. H. Compton. (*Ibid.*, pp. 117–30; figs. 6–12, April, 1900.)

(6) On an Abnormal Gynæceum in *Stachys sylvatica*, Linn. By A. W. Bartlett. (*Ibid.*, pp. 138–42; figs. 16, 17, April, 1909.)

observation of the authors', and is interesting from the analogy with the early Mesozoic genus Anomozamites, in which each fructification is in a terminal position in the fork between two vegetative branches.

The anatomy of the peduncle agrees with that in Stangeria, centripetal xylem occurring in the upper part, while small, blind-ending bundles, often of concentric structure, are present in the basal region.

Nodules, perhaps comparable to those of the Leguminosæ, occur on the roots. The authors regard the sympodial organisation of Dioon and Stangeria as primitive, and hold that the monopodial growth of the trunk observed by Prof. Pearson in Encephalartos is clearly a later development, and connected with the production of several cones simultaneously.

(4) Though for many years past no one has doubted that the fossil cones grouped under Calamostachys were the fructifications of calamites, the direct proof of continuity has so far been lacking in the case of those specimens which, at the same time, show the internal structure preserved. In this memoir Mr. Thomas records the discovery of the well-known petrified fructification *Calamostachys Binneyana* in connection with the vegetative organs of the plant to which it belonged. He has also made some interesting incidental observations—the probable presence, below the lowest whorl of bracts, of a disc comparable to the annulus of Equisetum, the presence of hairs (rare in this family) on the axis, and the close agreement in structure between the bracts and the vegetative leaves. The author has also observed impressions of cones and leafy shoots, which he refers to the same species with the petrified specimens, identifying both with the *Paracalamostachys Williamsoni* of Weiss and the *Asterophyllites (Calamocladus) grandis* of Sternberg. He suggests, with good reason, that the name *Calamostachys Binneyana*, hitherto used for the structural specimens, may represent a type rather than a species. In discussing the morphological questions involved, the author rightly emphasises the homology between bracts and foliage leaves, so clearly brought out in his specimens.

(5) *Utricularia brachiata* is a small species from the Sikkim Himalaya discovered by Sir Joseph Hooker; it grows, at an altitude of about 11,000 feet, on the trunks of *Abies Webbiana*, among moss. The plant consists of a flowering stem two or three inches high, a few reniform leaves, and several slender runners bearing tiny bladder-traps and tubers. The point of main interest, as in other species, is the morphology of the runners in relation to that of the leaves. The simple view that the "leaves" are phyllomes and the runners caulomes is rejected, on account of the innumerable transitions between the two, and the fact that the bladders are found indifferently on both. The theory that the runners are specialised leaves has been strongly maintained by Goebel, but the author, Mr. Compton, favours the alternative interpretation, advocated by the younger Schimper, that the runners are of the nature of stems, and that the "leaves" have been derived from similar organs by a process of flattening—that they are, in fact, phylloclades. The question is one of much difficulty; the author puts his case well, but we take exception to the argument that his interpretation "is without the theoretical demerit of the contrary view, in that it does not tend towards an abolition of morphological categories." The question as to the modifications that may have taken place in the organs of the genus Utricularia must surely be decided without reference to the convenience of the theoretical morphologist.

(6) Mr. Bartlett's little paper is a description of two flowering shoots of the common woundwort, found at Medstead, in Hampshire, which showed certain floral abnormalities, increasing in degree towards the apex of the shoot. In the extreme cases the pistil was represented by two hairy, foliaceous carpels, usually united by their edges below, and bearing abortive ovules. This teratological condition confirms the conclusion, based on development, that the pistil of Labiatæ is really bicarpellary, though the ovary is quadrilocular. The floral axis produced at its apex, within the modified ovary, one or more flower-buds—a case of Masters's "median floral prolification." D. H. S.

THE PRODUCTION OF BLACKWATER FEVER.[1]

DRS. WAKELIN BARRATT and Warrington Yorke have pieced together the result of their investigations, in the form of a report, undertaken for the blackwater fever expedition to Nyasaland. The object of the work was to determine how blackwater fever is produced; in brief, it may be stated that the authors have failed to accomplish this object. Incidentally, the work was intended to throw light on many of the uncertainties connected with the fever, and in this respect they have succeeded.

In simple language, blackwater fever is a fever which occurs in persons who have been treated with quinine, usually for malaria, and the clinical connection between the fever and the quinine has been placed beyond dispute. The authors, after studying the processes of the dissolving up of red blood corpuscles under a large variety of conditions, adduce ample evidence to show that the alkaloid quinine can hæmolyse red blood cells, but that a direct action of the alkaloid in the body is excluded, because the concentration of the quinine in the blood plasma of persons under treatment for malaria is utterly insufficient to produce an ascertainable amount of hæmolysis.

Since quinine plays a part in producing this peculiar condition, but does not cause it directly, it was necessary to look farther afield for other ætiological factors. The authors have investigated the condition of the plasma itself, since in another disease, in which dissolved blood corpuscles are seen, the hæmolysis has been proved to be due to a substance in the serum known as hæmolysin. No trace of such a substance could be found in the serum of blackwater-fever patients. They leave this riddle unsolved, and turn to the question of the situation in which the hæmoglobin is set free. Proof appears to have been found that the site is the blood itself, and not the kidneys or urine, as had been supposed. Another fact which has been brought to light by the authors is that the only change which occurs in the kidneys in uncomplicated cases of the fever is the appearance of a brownish material placed in the lumen of the renal tubules. No degeneration or other indications of pathological conditions are to be found.

Various other points are dealt with, and the reading of the work is materially assisted by the publication of summaries at the termination of each chapter. The theoretical reasoning is well carried out, and the work, while failing to solve a difficult problem, certainly illuminates many contributory factors in the production of blackwater fever. H. W. ARMIT.

THE ORGANISATION OF TECHNICAL EDUCATION.[2]

THE position of higher education has altered immensely in the last ten years since I ceased to be intimately connected with teaching. In the first place, the number of agencies engaged in the work has multiplied, the number of students they attract has grown, and the funds at their disposal are greatly larger. At that time there were two universities in England, besides the old foundations of Oxford, Cambridge, and Durham—London University, a purely examining body, and the Victoria University at Manchester, uniting the three colleges in Manchester, Liverpool, and Leeds. Now, if we may reckon Newcastle in addition to Durham, there are seven, each well equipped, and with a staff of professors competent and anxious to advance knowledge and to train their students for the duties of life.

But, besides this, there is in almost every important town a technical school or college supported by municipal funds, in two cases at least outside London an integral part of the university, everywhere doing work which must be done if we are to maintain our position in the world.

[1] "An Investigation into the Mechanism of Production of Blackwater." By Dr. J. O. Wakelin Barratt and Dr. Warrington Yorke. (Being the Report of the Blackwater Fever Expedition to Nyasaland of the Liverpool School of Tropical Medicine, 1907–9). *Annals of Tropical Medicine and Parasitology*, series T.M., vol. iii., No. 1, October. Pp. 256; with numerous illustrations and tables, &c. (Liverpool: University Press; London: Constable and Co., Ltd., 1909.) Price 10s. 6d.

[2] From the presidential address delivered to the Association of Technical Institutions on February 11 by Dr. R. T. Glazebrook, F.R.S.

I do not mean that these technical colleges are all new since 1899; most of them, possibly all, were in existence before that time, but their importance is now more fully realised, and the magnitude of their task more completely grasped, by those who are responsible for their maintenance and progress.

Turning to London, we have the University with its colleges, University College, King's College, and the East London College, struggling to realise under no small difficulties the ideal of a great teaching university, and doing it with increasing success; the Imperial Technical College, with its constituent parts; the Royal College of Science; the Royal School of Mines; and the City and Guilds College, which has just started with high aims on its difficult task; and the numerous technical colleges too many to mention, some of them old institutions inspired to new endeavours by the wise action of the Charity Commissioners, the generosity of city companies, the vivifying influence of the whisky money, or the foresight of the education authority for the county.

A list containing the names of these institutions throughout the country, showing the funds administered on their behalf, their staff of teachers, and their roll of students, would prove a formidable document, and if the list were compared with a similar one drawn up ten or fifteen years ago the amount of progress would be obvious. I am aware, of course, that if we compared it with a similar list drawn up for Germany or America, our numbers and resources would appear but small.

I do not direct attention to our growth in any spirit of self-glorification or with any view to suggest that we ought to be satisfied, but rather that you who are so well qualified to advise and to judge may take stock of the position, may ask yourselves whether your efforts are in all cases being well and wisely directed, what ought to be your aims, and what your own position relative to the other agencies around which have the same general object in view.

This is, I take it, the more necessary because of the probable large influx of additional work with which in the course of a few years educational authorities in all parts of the country will probably be called upon to deal, while here in London the need for some general consideration is the more urgent because of the work which the Royal Commissioners for the University of London are now engaged upon.

What are the aims which we whose work lies mainly with the technical institutions of the country have to set before ourselves? What is our position in the scheme of education which is gradually being evolved?

Now there are two sets of individuals, for each of which a somewhat different course of training is needed, those who are to be leaders in industrial pursuits and those who will ever remain among the rank and file. While it should always be possible for the workman to rise to the rank of leader—and your scheme of education must give full opportunity for this—the methods of a trade school aimed chiefly at giving to the workers in its district that fuller knowledge which makes their labour skilled must clearly differ from those of a college designed to give the highest technical training to those who are to lead and guide the workers.

M. Leduc, in a recent paper published in the *Bulletin de la Société pour l'Industrie nationale*—the Society of Arts of France—directs attention to the four-fold division of German instruction in technological science:—

(1) The comprehensive training which is to turn out the future captains and leaders of industry.

(2) The provision for putting trustworthy information on technological matters at the disposal of traders.

(3) Central institutions established for the scientific and practical study of special industries, and

(4) Local technical schools adapted to the special needs of particular localities.

In Germany, as we know, the great technical institutions have developed almost independently of the ancient universities.

The term university was, we are told, in the Middle Ages used to denote any community or corporation regarded under its collective aspect, but finally it came to mean a community of teachers and scholars whose corporate existence had been recognised and sanctioned by civil or by ecclesiastical authority, or by both. In its earliest stage it was probably a scholastic guild, a spontaneous combination of teachers and scholars formed on the model of the trades guilds or guilds of aliens, in great measure for mutual protection. In still earlier days learning flourished mainly, if not entirely, in the monasteries and cloisters, and the earlier universities took their rise in the endeavour to provide instruction beyond the range of the monastic schools. For the most part they were organised under the four faculties of theology, law, medicine and philosophy, or the arts, and they retained this constitution until the last century.

In Germany the activity and importance of the universities dates from the time after Jena, 1806, when, as we were reminded by Sir Norman Lockyer in his presidential address to the British Association in 1903, King Frederick William III. and his counsellors, among them Wilhelm von Humboldt, founded the University of Berlin "to supply the loss of territory by intellectual effort." In the main, however, it was founded on the ancient lines, and when later on in the century the problems of the application of science to industry had to be faced, and the technical high schools came into existence, they were developed independently of the universities.

By 1903 the separation from the universities had become definite. In Prussia the Emperor had recognised it by giving certain of the great schools the right to grant the degree of Doctor of Engineering, thus putting them on an equality with the universities, and by admitting the principals to the Prussian House of Lords, giving them the title of His Magnificence.

Now there are in Germany ten of these technical universities, at Dantzig, Berlin (Charlottenburg), Aix, Hanover, Munich, Carlsruhe, Dresden, Stuttgart, Darmstadt, and Brunswick, all over the length and breadth of the land, with nearly 12,000 fully qualified day students between them, and more than 2000 in addition whose qualifications are not complete. Last year 1668 diplomas were granted, and of those who received the diploma 130 took the degree of Doctor of Engineering.

The age at which these students begin their work is from eighteen to nineteen years, and the "matriculation for fully qualified students at German technical universities is the completion of the full nine years' secondary-school course at a classical, semi-classical, or modern secondary school." Besides these, there are the twenty older universities, with 48,000 students, of which a large number study chemistry and, to use a Cambridge official phrase, "other branches of physics." The students work for four years, usually after a minimum period of one year in works, and the aim of the institutions is to train experts, inventors, high technical State and municipal officials, captains of industry, owners of great works, professors, secondary teachers, engineers, architects, chemists, &c.

Besides these ten technical universities, there are special engineering and other technical schools for the training of owners and managers of small works, foremen, clerks of works, surveyors, draughtsmen, and the like.

Now I have not referred to this merely to mark our own deficiencies, but rather to afford some guidance as to the lines along which we are to develop. Are we to look forward to the growth of technical universities in each town arising naturally out of the colleges with which we are connected, but independent of, and at the same time rivals of, the universities which in many cases exist already alongside our own colleges?

The answer to this question must, I think, be in the negative, with possibly one or two exceptions—we will put aside, for the present, London and the two ancient universities—it would, I think, be suicidal to suggest that in Manchester or Birmingham, Leeds or Liverpool, there should be two degree-giving bodies, one connected with the arts, literature, and pure science, the other with those applications of science on which industry depends; and for this reason, among others. The universities of England are modern creations animated by modern ideas, and controlled by men whose main endeavour is to bring home to the mass of their countrymen the blessings of knowledge. The seclusion of the mediæval cloister, the quiet of the monastery, or even of the courts and quadrangles by the Isis and the Cam are not for them. They are placed amid the busy haunts of commerce, close to the foundry and the workshop, and their students seek to draw from ancient learning and from modern research alike those lessons of truth, those unerring laws of nature in accordance with which we must progress if our country is to remain great, to hold the premier place among the nations.

These universities will do for us what the technical high schools have done for Germany.

Let me note one important difference between their constitution and that of the ancient universities. They are not Republics; the Senate, the general body of professors and independent lecturers, is not the governing body. The court, with which control ultimately rests, is a large body representing all interests in the town and district. The court selects the council, which has executive power, and on both bodies the teachers have representatives; but in this way the effective management of the university is in the hands of a small body of business men ready to give the fullest attention to the wishes of the teachers, but capable of bringing other qualities to the consideration of the complex problems with which they have to deal, experienced in dealing with men and with affairs.

The prospects of the modern universities of England are bright; it is our business in our technical schools to supplement by all means in our power the efforts they are making to solve a difficult problem. Those who are to speak to-morrow can tell you better than I how the task is being done.

But with all the progress we have made we are still far behind Germany in very many vital respects. I am aware that the standard of entrance at our universities is being gradually raised; it will be long indeed before it reaches the nine years' secondary-school course required in Prussia for admission to any of its four technical universities. Still, we may look forward with some certainty to the time when our universities will do the work for England that those four universities do for Prussia; and while in some cases the connection between the technical college and the university will be very close, it is well to realise that there is an immense task before us which cannot be touched by the universities. University work is, in the main, day work; it calls for the whole time, the whole energy of the student; it may be that for a time, in some of its preliminary stages, some progress can be made by evening work, but a full university course demands more time than a hard-worked man should give after his day's task is done. The marked feature of the technical college is its evening work, the education it provides for those who have by day to make their living, raising and improving the quality of their work by training their intelligences, by putting clearly before them the why and the wherefore of the processes in which they take part.

I am not sure whether statistics exist as to the number of these students, the classes they attend, and the work they do. I have seen figures for London, and no doubt they might be obtained for the country at large. Few among these students hope to reach university standard, nor should their teaching be planned as though this were the main object in view. They fall, it seems to me, into two main categories, the adolescents—to use the word of the continuation schools report—who have recently left school to commence some trade, and for whom the continuation schools are designed, and then the older workmen, who want to understand the work they do, to prepare themselves for posts as foremen or overseers, and to be given some wider outlook on life than the shop or factory affords. There is room for a large development of both these tasks, for more coordination of the work, and greater continuity of effort. Elementary technical education is needed in all our towns, technical universities are needed in a few great cities only; for these latter we must concentrate both students and teachers.

A scheme whereby the evening technical institutions of a district would look to a technical university in one of the main centres of population as their university, would organise their work in connection with the day classes of the university, and would confine their own ambitions within moderate bounds, endeavouring to do their work within those bounds with the highest possible efficiency, would do much for the real interests of the nation. To promote such a scheme ought not to be a task beyond the powers of this association. It is a national work, and one which should readily gain the assistance of the national authorities.

In any scheme two matters must be borne in mind. A system of bursaries and scholarships must open the university to any student who can sufficiently profit by the opportunity thus offered; this is generally admitted; but, in addition, it should be possible for the teachers to advance knowledge by research and study. To do this in each technical school or trade school is clearly impossible. If its importance were once recognised, it ought to be possible to arrange for facilities for the work for teachers in the district in the laboratories and class-rooms of the university.

Oxford and Cambridge are outside any such scheme; London, again, offers special problems of its own.

The two ancient universities need not detain us long. England owes so much to them, and English science so much to Cambridge in particular, the home of Newton, Young, Cayley, Stokes, Kelvin, and Maxwell, to name mathematicians alone, that one who realises all the benefits Cambridge can bestow upon her sons can only express the very deepest regret that the regulations of the University still close her doors to many young Englishmen on whose future she could exert an inestimable influence for good; still, even if an elementary knowledge of Greek were no longer necessary for entrance, Cambridge must devote herself rather to the study of pure science than to that of technics and engineering; students who go to Cambridge are prepared to spend time and money in gaining other advantages besides those of their technical education. Cambridge does not aim at being one of the great technical universities, but rather a home of sound learning and religious education from whence may spring great generalisations and new ideas to fertilise the world.

As to London, the problem is most complex. We have the university, the university colleges, now happily a part of the university itself, the Imperial Technical College, with its own constituent parts, the Royal College of Science, the Royal School of Mines and the City and Guilds College, the Finsbury Technical College, and the various polytechnics and trade schools. What, from our point of view, are to be their connections, and under what scheme can they best combine to meet the wants of the seven millions of people for whom they provide?

We have to provide for the masters and leaders of industry by institutions giving a wide and comprehensive training suited to their needs; we have to secure that the workers shall be able to gain the knowledge needed to make their labour fruitful to themselves and to the State, when young in technical schools adapted to the requirements of their trade, and when more mature in more highly specialised institutions organised to promote the scientific and practical study of special industries.

There is yet another class, limited in numbers, but valuable beyond measure to the State, those to whom it is given to advance learning—the potential Faradays of this great city.

For the first class we have the university, with its constituent colleges and parts; but are we to have one university or two? Shall London University embrace, as its name would imply, the whole of learning, the arts and sciences, literature, economics, theology, law, medicine, and the technical applications of science, or are we, like Berlin, to have two universities side by side, the one dealing with the older studies and pure science, the other the technical university, taking under its care those practical developments of science on which the welfare, nay, the very life, of the country hangs?

The matter is now under consideration, and this is, perhaps, hardly the place to discuss it. I would only say that the example set by Germany, though to follow it would entail many difficulties, is not lightly to be set aside. In any case, some change must come in the present government of the university—a change, I trust, which will place the executive control of its fortunes in the hands of a much smaller body than the Senate, will leave the various faculties more free to develop on the lines best suited to each case, and will concentrate more completely than is at present possible the highest studies, affording to its students the opportunities which they now lack for post-graduate study and original research.

At any rate, we may take it that the Imperial Technical College will become the technical university for London—whether as a part of London University or as a new university working alongside it does not for our present purpose matter—concerned chiefly with honours students entering with high qualifications for a three or four years' course, including post-graduate study and research.

While referring to research, let me say I do not think you can successfully command a college, either by Act of Parliament or by Royal Charter, to become the home of original research. You can foster the endeavour by your regulations and the proper provision of funds, but success depends mainly on the men who guide the students and direct their energies. It was Liebig who made Giessen; the physical laboratory of Berlin became famous because Helmholtz worked there; it was not the cellar in the old university buildings, or the funds available for inquiry, which drew students from all over the world to Kelvin's laboratory at Glasgow. Rowland and his staff are the real founders of the Johns Hopkins University; to-day it is Thomson who fills the Cavendish Laboratory and Ramsay who attracts our ablest chemists to a somewhat second-rate laboratory in Gower Street. To expect a distinguished body of post-graduate students to flock at once to a newly opened college is a vain hope; but this is a digression. The Imperial Technical College will in time become the technical university of London. To achieve all that is aimed at, time and a more generous support on the part of those who have interests of education at heart alone are needed.

To this university there must be many avenues of approach; it must spread its roots afield; among its students some—by no means all—will pass through the polytechnics, for it appears to me the primary work of the polytechnics is not to prepare undergraduates for degrees in science and engineering, but rather, in the first instance, to supply needful knowledge to the worker.

No doubt it is necessary that, in view of the size of London, there should be centres of university work in various parts; it is desirable that some of the polytechnics should organise themselves so as to meet this demand; but is it necessary for all to do so? I do not wish to express an opinion so much as to raise a question.

I think I realise in part the feelings of the teachers; their university students are, I take it, among their best; the chance of doing research work turns largely on having one or two such students, and research work must be done if your teaching is to be kept alive and your courses, at any rate to advanced students, made fruitful; but is the highest work, or even work up to degree standard in many subjects, to be attempted in every polytechnic? The expense of such a plan must be very heavy, the strain on the teachers enormous. Suppose that, instead of endeavouring to cover all the instruction required for the B.Sc. degree, each institution made a serious effort to specialise only in one or two of the required subjects, leaving the others to other polytechnics, would not this relieve the pressure? In this chosen subject the principal would draw round him a large and able staff who would attract students from a wide area, and his college might in time become a specialised school of technical research. The teachers in this subject would find in their work ample opportunities for investigations of real importance; in the other branches of science the work would be avowedly more elementary, and the teachers probably less competent to research: but if the classes were mainly evening, such of the staff as wished might carry on investigation in the central laboratories of the university, or possibly at some other polytechnic where the subject of the research was made a special object of study.

One point more. Among your many students are some of very marked ability, perhaps of genius. Ease their paths by all methods within your power. Let me urge on the governors of your various institutions, and on those who hold the purse, if there are any such who can hear me, that expenditure on scholarships or bursaries for such, on material and apparatus for their researches, will soon repay itself in the effect their work will have in applying science to industry and trade, in discovering new means whereby the forces of nature may be harnessed to do the work required by man.

To conclude; my dream would picture a central technical university for London, a place where students only of proved capacity were admitted, where the staff were free to conduct original investigations and through these to teach their students, where scholars and prizemen from the various technical institutions of the district were collected, and where the teachers in the polytechnics and other colleges were freely welcomed to carry out researches.

In close connection with this there would be a number of colleges, day colleges chiefly, organised so as to provide the teaching required for the less advanced stages of the university. The suitable centres for this work would, of course, need to be selected with due regard to geographical conditions. Beyond these, again, would come the polytechnics, engaged chiefly in evening classes for the worker, but each with its one or more departments organised so as to provide teaching and means for research of the highest character, with its teachers recognised by the university, having a common interest in promoting the welfare of the central body and looking to the professors as their leaders in the search for truth.

Whether this dream comes true or not, I am clear that a scheme for technical education in London must aim at coordinating existing effort round a central institution, and in this endeavour must recognise the self-sacrificing labours of those who, in the past ten years, have done so much to forward the great movement—the governors and the staff of the institutions represented on this association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The general board of studies will shortly proceed to the appointment of a Stokes lecturer in mathematics, in succession to Prof. Hobson. The appointment will be from June 24, 1910, to September 29, 1913. The annual stipend is 200*l*. Candidates are requested to send their applications, with a statement as to the branches of mathematics on which they are prepared to lecture, and with testimonials if they think fit, to the Vice-Chancellor on or before April 25.

The Allen scholarship has been awarded to Mr. R. Whiddington, of St. John's College. Mr. Whiddington took a first class in physics in part ii. of the natural sciences tripos in 1908.

SIR ALFRED KEOGH, K.C.B., formerly Director-General of the Army Medical Service, has accepted the rectorship of the Imperial College of Science and Technology, and will take up his work at an early date.

A REUTER message from Bombay announces that Sir Carrimbhoy Ebrahim has given to the Bombay Government a sum of 30,000*l*. for the improvement of scientific training, the encouragement of research, and the provision of scholarships to science students of the Mussulman faith.

A MEETING of the London branch of the Mathematical Association will be held at the L.C.C. Training College, Southampton Row, W.C., on Saturday, March 19, at 2.30 p.m. Papers will be read on the teaching of graphs, by Dr. T. Percy Nunn and Mr. P. Abbott. A discussion will follow, which will be initiated by Mr. D. Mair. All who are interested in the work of the association are invited to attend.

THE Fresenius Chemical Laboratory, Wiesbaden, offers opportunities for the pursuit of study and research in chemical science in an attractive part of Germany. The directors of the institution are Prof. H. Fresenius, Prof. W. Fresenius, and Prof. E. Hintz, and there is a large staff of lecturers and assistants. The summer term will begin on April 25, and among the subjects of lectures announced are chemical technology, stöchiometry, microscopy and chemistry, and analysis of foods. Copies of the regulations and the syllabus of lectures may be obtained upon application to one of the directors of the laboratory.

THE Old Students' Association of the Royal College of Science, London, has commenced the publication of a *Record*, which is to be issued at irregular intervals as occasion may demand, containing information in regard to the work of the association and other matters of interest to old students. The association has accomplished some useful work during the first year of its existence. A register containing particulars of 729 old students has been published, steps are being taken with a view to secure academic costume for associates of the college, and inquiries are being made with the intention of offering evidence before the Royal Commission on University Education in London. We notice that Sir Thomas Holland, K.C.I.E., F.R.S., is the president of the association for the current year.

MR. F. M. DENTON, of the Carnegie Technical Schools, Pittsburgh, has been appointed to the post of associate-head of the electrical engineering and applied physics department of the Northampton Polytechnic Institute, Clerkenwell, London, E.C., rendered vacant by the resignation of Dr. C. V. Drysdale. Mr. Denton received his technical training at the Central Technical College of the City and Guilds of London Institute, and for a time he occupied a position on the staff of the electrical engineering department of the college. He left to join the staff of the General Electric Company in various departments at Pittsfield, Mass., and at Schenectady. After occupying these positions for one year he was, two and a half years ago, appointed lecturer in electrical engineering at the new Carnegie Technical Schools at Pittsburgh, a position which he still occupies and is resigning to take up his London appointment.

THE Department of Agriculture and Technical Instruction in Ireland has distributed a circular (Form S 41) giving full particulars of its summer courses of instruction for teachers, to be held, for the most part, in Dublin during July and August next. In July, courses will be conducted by the Department in, among other subjects, experimental science, laboratory arts, and drawing and modelling for teachers in day secondary schools, and in day and evening science and art classes; in domestic economy and woodwork for teachers in day secondary schools; and in hygiene and sick nursing and in housewifery for domestic economy instructresses. For August, four courses have been arranged, as follows:—in metalwork, practical mathematics and mechanics, and in handrailing, for teachers of wood-working; in industrial chemistry for teachers of chemistry in technical schools; in rural economy for teachers of experimental science in technical schools and teachers in national schools; and in school gardening for teachers in schools with gardens. The syllabuses of work contained in the circular show that great pains have been taken to provide practical courses dealing with subjects which will be directly useful to teachers in their work, and they should also serve the purpose of adding new life to their lessons when the teachers return to their schools.

ON Friday, March 11, Sir William H. White, K.C.B., F.R.S., distributed the certificates and prizes at the South-western Polytechnic Institute, Chelsea. Mr. W. Hayes Fisher, M.P., occupied the chair. After the principal had read the report for the session 1908–9, and the certificates had been distributed, Sir William said that in education he has three articles of faith, namely:—(1) every child should have an opportunity for education; (2) all who give proof of capacity of profiting by higher training must be allowed to go on; (3) in getting the best educational results the natural process of gradual selection must be adopted and allowed to operate. This leads to apparent wastage; but there is no real wastage. It is necessary to have educated men of all grades in all works, and this has specially to be brought home to the English manufacturer, who does not yet realise the importance of higher education. Sir William said that in Chelsea he felt at home, for when he came from Devonshire, before he joined the Admiralty in 1867, he studied at the School of Practical Shipbuilding at South Kensington, and lodged on King's Parade, Chelsea, almost within a stone's throw of the polytechnic. He was very pleased with his inspection of the polytechnic last week, and specially congratulated the governors on the large amount of their day work. From his experience of the technical colleges and institutes in London he had come to the conclusion that the polytechnics must be encouraged to carry on and extend day courses—their work in the evening was without parallel in the educational world. Various subjects must not be concentrated in special buildings, but each institute should make its courses as wide and as general as possible. London was so extensive, and its population was so large, that there was an ample field.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 10.—Sir Archibald Geikie, K.C.B., president, in the chair.—C. Gordon **Douglas** and Dr. J. S. **Haldane**: The causes of the absorption of oxygen by the lungs (preliminary). A short preliminary account is given of experiments affording clear evidence of a secretory activity of the lungs in the absorption of oxygen.—V. H. **Veley** and A. D. **Waller**: The action of nicotine and other pyridine bases upon muscle, and on the antagonism of nicotine by curarine. Nicotine (mol. wt. = 162) as such, or in the form of salt as nicotine tartrate, produces a very characteristic effect upon the contraction of isolated muscle. Its toxic power upon muscle, as compared with that of other substances that the authors have dealt with, is of the following order, *i.e.* approximately one-third that of quinine and considerably greater than that of curarine:—

Aconitine ...	10,000
Quinine ...	100
Nicotine ...	33
Strychnine ...	12
Curarine ...	5

The effect on muscle, characteristic of nicotine, is not produced by its parent base pyridine, nor by picoline, nor by piperidine. The order of toxicity upon muscle of these substances as compared with that of nicotine is as follows:—

Nicotine ...	100
Piperidine ...	50
Pyridine ...	10
Picoline ...	10

As has been indicated by Langley, there is an antagonism between nicotine and curare. Using a solution of pure curarine iodide prepared by Prof. Boehm, we find that the characteristic effect of nicotine upon muscle is abolished when the proportion of curarine to nicotine, reckoned by molecules, is 2 to 1, 30 to 1, and 160 to 1. With this last proportion a trace of nicotine effect can still be detected. In the case of other poisons, viz. strychnine, quinine, and aconitine, of which the effect *per se* upon muscle considerably exceeds that of curarine, there is, in a sense, an antagonism, as shown by abolition of the characteristic nicotine effect, but the abolition requires a greater mass of these more powerful poisons than is sufficient in the case of the less powerful poison—curarine. Thus, approximately, whereas 1 mol. of curarine can overpower upwards of 100 mols. of nicotine, it requires 1 mol. of strychnine or of quinine to overpower 1 mol. of nicotine, and 1 mol. of aconitine can overpower at most 10 mols. of nicotine. But in these cases the result appears to the authors to be intelligible as an effect of subdivision of muscle stuff between two poisons similar to the case of the subdivision of an acid between two bases; but this explanation is hardly applicable to the case of the antagonism of the strong poison nicotine by the weak poison curarine.—Prof. H. E. **Armstrong** and E. H. **Horton**: Studies on enzyme action, xiii., enzymes of the emulsin type.—Miss M. P. **FitzGerald**: Preliminary note on the origin of the hydrochloric acid in the gastric tubules.—C. J. T. **Sewell**: The extinction of sound in a viscous atmosphere by small obstacles of cylindrical and spherical form. The results obtained in this paper are only valid when the dimensions of the obstacles are small compared with the wave-length of the incident sound. For cylinders and spheres the radius of which is not less than 10^{-3} cm. it is found that the ratio of the lost energy to that incident upon the obstacle is at most of order 10^{-2}; this is a very much larger proportion than is obtained in the case of a non-viscous air. The results obtained for a single obstacle are extended without difficulty to the case of a large number of obstacles. This extension is valid only when the space occupied by the obstacles is small compared with the total volume. It appears in the case of spherical obstacles that, if each small obstacle has radius 10^{-3} cm., and there are 10^6 of them per cubic centimetre, then sound of wave-length 50 cm. will have its intensity diminished in the ratio of $1/e$ after passing through a thickness of less than 12 cm. of such a medium.—Dr. R. D. **Kleeman**: The ionisation of various gases by the β rays of actinium. A set of experiments carried out on the ionisation in various gases by the β rays of actinium. The results are of interest in comparison with the ionisations produced by the β rays of uranium, on account of the different penetrating powers of the rays. The results are exhibited in the subjoined tables. It will be seen that the relative ionisations by the β rays of actinium are practically the same as those obtained with the β rays of uranium.

Scattering of β Rays.

Absorbing substance	β Rays of actinium (Godlewski)	β Rays of uranium (Rutherford)
Aluminium	32·7	14
Mica	33	17·2
Brass	108	—
Copper	139	60
Tinfoil	154	—
Lead	163	122

Relative Ionisations.

Vapour	β Rays of actinium	β Rays of uranium
Air	1·00	1·00
H_2	0·159	0·165
$C_4H_{10}O$	4·28	4·39
C_2H_5Cl	3·33	3·24
C_2H_5Br	4·43	4·41
CH_3F	5·34	5·11

Geological Society, February 18.—Annual general meeting.—Prof. W. J. Sollas, F.R.S., president, in the chair. —Prof. W. J. **Sollas**: Anniversary address: the evolution of man in the light of recent investigations. Considering first the human remains of the Pleistocene epoch, the president pointed out that, so far as the evidence extends, it shows that the cranial capacity of the human skull increases rather than decreases as we pass backwards in time. The oldest known human skulls are later than the Chalky Boulder-clay. The cranial capacity is merely a morphological character of unknown significance. Observation shows that no discoverable connection exists between it and the intellectual power. The most recent researches in comparative anatomy emphasise the close connection between man and the anthropoid apes, especially the gorilla and the chimpanzee. A similar result is afforded by the investigations of Uhlenhuth and Nuttall into blood-relationship. All recent researches converge to show that the genealogy of man is to be traced through the anthropoid apes and the catarrhine monkeys to the lemurs. Cope's suggestion of a direct descent from extinct lemurs receives no confirmation. Primitive characters, when present in man, can be better explained by regression and adaptation. Man probably diverged from the phylum of the primates above the point of origin of the gibbon, and not far from that of the gorilla and the chimpanzee. He owed his progress, in the first place, to emancipation from a forest life, and commenced his career as the ape of the plains. The erect attitude and the use of the hand as a universal instrument followed as a consequence. Ancestral man was probably a social animal at a very early period, and social life afforded a stimulus to the development of the powers of speech. He was probably distinguished by great bodily strength and by the possession of formidable natural weapons of defence and offence. With the invention of weapons made by art the necessity for natural weapons disappeared, and a regressive development of the teeth with adaptation to purely alimentary functions commenced. A purely human dentition characterises the Heidelberg jaw, which is the oldest known. This, however, still reveals in all other respects strong simian affinities. The growth of the brain in size and complexity might be correlated with the evolution and use of the hand, but to a far greater extent with the development of the powers of speech and the consequent exchange, multiplication, and coordination of ideas.

February 23.—Prof. W. W. Watts, F.R.S., president, in the chair.—T. O. **Bosworth**: Metamorphism around the Ross of Mull granite. The Ross of Mull granite is a coarsely crystalline plutonic mass, forming the western portion of the Ross of Mull, and extending over some twenty square miles. The intrusion is conspicuously later than the Moine rocks, and is regarded as one of the "newer granites." The rock shows very little evidence of faulting or movement of any kind, and is traversed by sheets of mica-trap. The eastern boundary of the granite is a very intricate line of junction with typical Moine schists and gneisses, into which it has been intruded. Injection-breccias occur along the margin, where the granite is crowded with schist-inclusions. The changes in the pelitic schists are of two kinds, and are considered under the separate headings (*a*) impregnation, and (*b*) thermal metamorphism.

Zoological Society, March 1.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—Sir G. F. **Hampson**: A list of the moths collected by Mr. Sheffield A. Neave in Rhodesia north of the Zambezi and the adjacent Katanga district of the Congo Free State. Nearly two hundred new species are described. The moth fauna of the district is mainly of a West African type, with a considerable admixture of East African and Mashonaland forms. As there are no high ranges of mountains or deep river valleys, the fauna presents a very uniform tropical African character, with no high mountain forms or forms peculiar to the faunas of the drier parts of southern or northern Africa.—T. H. **Burlend**: The urogenital organs of *Chimaera monstrosa*. This paper dealt with the urogenital organs of Chimæra, both immature and adult of each sex. Much of the early work of Leydig and Hyrtl, which later writers had ignored or disputed, was now confirmed and supplemented.

Royal Anthropological Institute, March 8.—Sir Herbert Risley, president, in the chair.—Dr. A. **Keith**: The Gibraltar skull. This skull was presented to the Museum of the Royal College of Surgeons, England, some forty years ago by Mr. Edward Busk. Huxley had seen the cranium, but evidently did not recognise that it was of the same type as the Neanderthal skull. The merit of discovering that this skull was Neanderthaloid and belonged to that ancient Palæolithic race of men to which Schwalbe has given the specific name of *Homo primigenius* belongs to several anthropologists, but to Prof. Sollas must be ascribed the merit of having given, quite recently in the Philosophical Transactions, the first detailed description. The skull deserved further investigation, because it was the only specimen of Neanderthaloid man yet known that showed the face in a perfect condition. In the two recently discovered examples described by M. Marcellin Boule and by Prof. Klaatsch, the facial parts were so mutilated that reconstruction was necessary to obtain an approximate conception of the original or natural form. Dr. Keith, with the aid of Mr. F. O. Barlow, had been able to obtain a cast of the interior of the skull, and was thus able to study certain surface markings of the brain. The brain-cast was remarkable for its width and for its flatness; the left occipital pole predominated over the right occipital pole, a character that has been associated with right-handedness. The fissure of Sylvius was wide and apparently open, but this character is due, as in native Australian brains, to the great size of the ridge of bone which occupies the fissure. It has been found possible to expose the sutures of the Gibraltar skull, and thus to localise definitely important points in its topography. The cerebral development of Palæolithic man has been very much underestimated. This is partly due to the fact that the height of the skull was measured from the inion to the glabella, two points which are fairly stationary in modern men, but which in Palæolithic men, as in anthropoids, grew upwards so as to occupy a relatively high position as regards the brain. These points are from 8 to 10 mm. higher in Palæolithic men; hence the height of the skull, when measured from them, is comparatively low. M. Boule has found the capacity of the La Chapelle skull to be considerably above the average for modern Europeans, and such was undoubtedly the case as regards the Neanderthal and Spy crania. In the Gibraltar skull the capacity was low, below 1100 c.c., a small amount, partly owing to the skull probably being that of a woman and also to the fact that it was pre-Neanderthaloid in type. Indeed, when rightly analysed, the Gibraltar individual, as regards the type of cranium and size of brain, is intermediate between Pithecanthropus and Palæolithic skulls, such as those of the La Chapelle man or the skull known as Spy ii. The mastoid of the Gibraltar skull is simian in type; the groove for the attachment of the digastric muscle is exposed laterally, as in the anthropoids, in place of being covered by the mastoid processes. Palæolithic men were distinguished by the width of the attachment of the skull to the neck, as well as by the simian supraorbital ridges. The nose of the Gibraltar individual is unlike anything yet seen in a human being. Although in certain features it shows approximation to the gorilla, it is best described as the precursor of the prominent European nose. The jaw is remarkable for its width; in length it does not much exceed that of a modern European. The third molar is larger than the second, at least one so infers from the parts that still remain. This shows a very robust dental development. It is evident that Palæolithic man had reached quite a modern degree of brain development. If the Gibraltar individual be assigned to a Palæolithic date, for we can assign its period only from its conformation, there being no accessory data, then it must be assigned to a woman of a much lower brain development than the men now assigned to that period; but it is also possible that it belonged to a much earlier date than the Neanderthal-Spy men—to a race we know nothing of as yet. Dr. Keith also pointed out that in the pathological condition, known as acromegaly, the eyebrow ridges and attachment of the skull to the neck became enormously increased, thus reproducing a character which was normal in Palæolithic men. It seemed very probable that racial characters were determined by secretions of the more obscure glandular organs of the body, especially the sexual glands.

Mathematical Society, March 10.—Sir W. D. Niven, president, in the chair.—J. W. **Nicholson**: The scattering of light by a large conducting sphere.—Miss H. P. **Hudson**: The 3-3 birational space transformation.—W. F. **Sheppard**: The expression of the sum of the rth powers of the first n natural numbers and other similar functions of n in terms of $n+\frac{1}{2}$, and forms for the remainder in the Euler-Maclaurin sum-formula.

Linnean Society, March 3.—Mr. H. W. Monckton, treasurer and vice-president, in the chair.—W. **Bickerton**: Our British nesting terns.

PARIS.

Academy of Sciences, February 28.—M. Émile Picard in the chair.—Émile **Picard**: A general theorem of certain integral equations of the third species.—J. **Boussinesq**: The manner in which the potential of the velocities depends upon the initial state in the problem of waves by emersion.—A. **Haller** and A. **Brochet**: The oxidation of methyl ricinoleate by ozone. The ester fixes four atoms of oxygen on treatment with ozonised oxygen. The separation of the products formed by the interaction of this substance with sodium carbonate is described in detail; the position of the double linkage thus determined is in agreement with the constitution usually ascribed to this acid.—M. **Lannelongue**: A supplementary function of the foot in the yellow race. The foot in these races is not exclusively used for the support of the body. It is used for other functions, and becomes a prehensile organ, as in grasping an oar.—Émile **Borel**: A general condition of integrability.—Émile **Cotton**: Asymptotic solutions of differential equations.—Serge **Bernstein**: The conditions necessary and sufficient for the possibility of the problem of Dirichlet.—Joseph **Marty**: An integral equation.—Léopold **Fejér**: A pair of conjugated Fourier's series.—J. B. **Fournier**: A method of evaluating the temperature of superheated vapour. Superheated steam differs from saturated steam in that adjacent portions may have very different temperatures, and this fact has not been sufficiently appreciated in many instances when fixing the position of the thermometer designed to give the temperature of the superheated vapour. The error may amount to as much as 75°. The whole of the bulb, or corresponding portion of an electrical instrument, must be entirely immersed in the direct current of vapour, and contact with the walls of the pipe must be avoided.—Ch. **Féry**: A symmetrical coil for galvanometers with movable frame.—G. **Gabet**: The results obtained in the radio-automatic torpedo by a new telecommutator. The principles upon which the apparatus is based were given in a previous communication. Practical tests in the Seine have been successfully carried out.—E. **Louise**: A new method of analysis by miscibility curves. Application to essence of turpentine. Aniline is a suitable solvent for this work, four curves obtained with this substance being illustrated.—E. **Baud**: Cryoscopy in concentrated solutions. The concentration is taken as the weight of the solute dissolved in a given volume (100 c.c.) of the solution, a non-polymerised solvent being used. Results are given for ethylene bromide, benzene, and nitro-benzene as solvents.—G. **Denigès**: The detection of traces of formaldehyde in presence of acetaldehyde by fuchsine bisulphite. In liquids acid with sulphuric acid the red colour restored to the decolorised fuchsine solution by the acetaldehyde is much less stable than that produced by formaldehyde. The latter tends to increase on standing, the former to fade away.—F. **Bodroux** and F. **Taboury**: Syntheses effected with benzyl cyanide. Nitriles in ethereal solution react readily with sodium amide, giving sodium derivatives of the type R.CH.Na.CN. The latter can be converted into compounds R.CHR'.CN by alkyl halides. Several examples of the application of the reaction are given.—J. **Bougault**: α-Cyclogeranic acid. The acetate of trimethylcyclohexenol is obtained in good yield by heating α-cyclogeranic acid with an acetic acid solution of mercuric acetate.—Marcel **Delépine**: The constitution of the dimeric aldehyde of crotonaldehyde.—A. **Wahl** and C. **Silberzweig**: The methyl methoxybenzoylacetates. The methyl esters, differing from the ethyl esters, can be distilled undecomposed in a vacuum. These compounds were prepared by Claisen's method. Details of the preparation and properties of these compounds are given.—A. **Backe**: A new compound contained in food products. The reactions of this substance are sufficiently close to those of salicylic acid to give rise to the suspicion that the latter substance has been added. This body is formed by the action of heat on certain sugar and starches, and resembles the maltol of Kiliani and Barlen.—Louis **Matruchot**: A new group of pathogenic fungi causing sporotrichosis.—G. **André**: The development of a bulbous plant. Variations in the weight of the dry material.—Ed. **Urbain**, Cl. **Scal**, and A. **Feige**: The sterilisation of water by the ultra-violet rays. The source of light employed was an arc formed between carbons containing alumina. It is pointed out that it is useless to attempt to utilise wave-lengths below 1860 Ångström units, since a thin layer of quartz or water absorbs nearly all rays of lower wave-length.—Mlle. **Cernovodeanu** and Victor **Henri**: A comparison of the photochemical and abiotic action of the ultra-violet rays.—I. **Chaine**: The vertical position and the thigh muscles.—C. **Vaney** and A. **Conte**: Researches on the development of the egg of the silkworm.—Paul **Hallez**: The summer and winter spawning of *Prostoma lumbricoideum*.—J. **Nageotte**: The microscopical study, during life, of the activity of the myeline in the course of the Wallerian degeneration of nerves.—M. **Favre** and Cl. **Regaud**: Certain filaments having probably the signification of mitochondria in the generating layer of the epidermis.—F. **Bordas**: The medico-legal study of the benzidine reaction in the determination of blood spots. If the reaction is negative, blood is certainly absent; it is shown, however, that a positive reaction is given by substances other than blood.—E. **Doumer** and G. **Lemoine**: Obstinate neuralgic pains observed in patients suffering from excessive arterial tension.—Jean **Brunhes**: The predominance of erosion on the right bank of a river in times of flood.—Alfred **Angot**: The secular variation of the magnetic elements in the region of Paris.

March 7.—M. Émile Picard in the chair.—Maurice **Hamy**: The organisation of stellar spectroscopy at the Observatory of Paris. Details are given of the new spectrograph, specially designed for the determination of radial velocities. Special attention has been given to securing constancy of temperature, with such success that the variations during several months have amounted to two- or three-hundredths of a degree.—J. **Boussinesq**: The integration of the equations of waves of emersion by Maclaurin's formula, in series always convergent, for a deep, endless canal and for an indefinite basin.—A. **Haller** and Ed. **Bauer**: The alkylation of fatty ketones by the use of sodium amide. By successive treatments with sodium amide and methyl iodide, pinacoline was converted into $(CH_3)_3.C.CO.CH_2.CH_3$, and ultimately into

$$(CH_3)_3.C.CO.CH(CH_3)_2.$$

In benzene solution this was further acted upon by sodium amide and methyl iodide, the symmetrical hexamethylacetone $(CH_3)_3.C.CO.C(CH_3)_3$ being formed. Various derivatives of these ketones, together with the corresponding ethyl compounds, are described.—Richard Dedekind was elected a foreign associate.—H. **Andoyer**: New fundamental trigonometrical tables.—J. **Guillaume**: Observations of the sun made at the Observatory of Lyons during the third quarter of 1909. Observations were possible on sixty-seven days, the results being summarised in three tables, showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Ch. **Gallissot**: The phenomenon of Purkinje. An experimental study of the luminosity of two points, red and blue. The brightness of these artificial stars could be altered by known amounts. It is concluded that Purkinje's phenomenon has no sensible influence from the sixth magnitude upwards.—Arnaud **Denjoy**: The measurement of *ensembles*.—M. **de Séguier**: The symmetrical group and the alternating group.—W. **Stekloff**: The development of an arbitrary function in series proceeding in accordance with certain fundamental functions.—Joseph **Marty**: Developments according to certain singular solutions.—Sigismond **Janiszewski**: Contribution to the geometry of general plane curves.—M. **Hadamard**: Liquid waves.—Marcel **Brillouin**: Questions of mathematical physics.—A. **Dufour**: Unsymmetrical triplets; an example of an asymmetry of position proportional to the square of the magnetic field. The chromium line 5247·56 forms a triplet in the magnetic field the axis of symmetry of which is displaced towards the violet. This asymmetry of position with respect to the initial line increases as the square of the field.—E. **Caudrelier**: The discharge of inductors: the capacity of the electrodes.—André **Kling**: A new method of estimating dextro-tartaric acid. The estimation is based on precipitation as calcium racemate.—Léo **Vignon**: The diffusive power of certain artificial colouring matters. A study of diffusion shows that dye-stuffs considered as soluble in water fall into two clearly differentiated groups; those of the first group, of which picric acid is the type, form true solutions; those of the second group are only apparently soluble, and are incapable of diffusion, such as Congo red.—Pierre **Dupuis**: The action of phosphorus trichloride upon guaiacol.—Aug. **Chevalier**: The forest resources of the Ivory Coast. Results of the scientific expedition in western Africa. The products include kola and coffee, both in the wild state, a gum analogous to gum arabic, and several gum-resins.—Auguste **Joxe**: The modes of opening of achenes and kernels at the time of germination.—Ed. **Griffon**: Variation in grafting and asexual hybridation.—Gabriel **Vallet**: The penetration and bactericidal action of the ultra-violet rays with respect to the chemical constitution of the media.—H. **Bordier** and R. **Horand**: The action of the ultra-violet rays on trypanosomes. *Trypanosoma lewisi* in the blood of a rat was killed by an exposure for fifteen seconds to the ultra-violet rays of a quartz mercury vapour lamp. These trypanosomes were absolutely unaffected by a prolonged exposure to the X-rays.—Mme. Marie **Phisalix**: The natural immunity of batrachians and snakes against the poisonous mucus of the former: the mechanism of this immunity.—A. **Briot**: Properties of the serum of sero-anaphylactised rabbits.—R. **Robinson**: The dimensions of the cæcum and typhlectasis.—J. **Thoulet**: A lithological submarine map of the coast of Languedoc.—B. **Galitzine**: The determination of the epicentre of an earthquake from the data of a single seismic station.

DIARY OF SOCIETIES.

THURSDAY, MARCH 17.

ROYAL SOCIETY, at 4.30.—*Bakerian Lecture*: The Pressure of Light against the Source: the Recoil from Light: Prof. J. H. Poynting, F.R.S., and Dr. Guy Barlow.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Further discussion*: (1) Short Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings: (2) The Design of Turbo Field Magnets for A.C. Generators with Special Reference to Large Units at High Speeds: Miles Walker.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual Meeting.—*Followed by*: The Surface Condenser in Mining Power Plant: W. A. MacLeod.

LINNEAN SOCIETY, at 8.—The Life-history of *Chermes himalayensis*, Steb., on the Spruce, *Picea morinda*, and Silver Fir, *Abies Webbiana*: E. P. Stebbing.—A Contribution toward a Knowledge of the Neotropical Thysanoptera: R. S. Bagnall.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Compounding and Superheating in Horwich Locomotives: G. Hughes.

OPTICAL SOCIETY, at 8.—Some Measurements of Stereoscopic Power: D. P. Boatman and R. J. Lucking.—Optical Instruments for Naval Purposes: T. Y. Baker.

FRIDAY, MARCH 18.

ROYAL INSTITUTION, at 9.—The Dynamics of a Golf Ball: Sir J. J. Thomson: F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of Warships: N. Maas.

SOCIETY OF DYERS AND COLOURISTS, at 8.—The Coal Tar Colour Industry of England; the Causes of its Progress and Retardation: Ignatius Singer.

SATURDAY, MARCH 19.

ROYAL INSTITUTION, at 3.—Electric Waves and the Electromagnetic Theory of Light: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 21.

VICTORIA INSTITUTE, at 4.30.—Light, Luminaries and Life: Rev. A. Irving.

INSTITUTE OF ACTUARIES, at 5.—(1) On the Valuation of the Payment on the Death of a Pensioner of the Excess of his Contributions, with or without Interest, over his Pension Payments; (2) On a Method of Scheduling Particulars for the Valuation, in certain cases, of Prospective Pensions based on Terminal Salaries: T. Tinner.

TUESDAY, MARCH 22.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: Birmingham Sewage-disposal Works: J. D. Watson.—Salisbury Drainage: W. J. E. Binnie.

WEDNESDAY, MARCH 23.

GEOLOGICAL SOCIETY, at 8.

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