THURSDAY, OCTOBER 13, 1898.

THE NATIONAL PHYSICAL LABORATORY.

THOSE who remember the address by Prof. Lodge at Cardiff, in which he advocated the establishment of a National Physical Laboratory, and the feeling of hopelessness with which the suggestion was received, will be confirmed in the view that the world moves by the fact that a Treasury Commission has now reported in favour of the scheme. Sir Douglas Galton dealt with the question in his presidential address at Ipswich, and, on the following day, read a paper on the Reichsanstalt before Section A. That body then took the matter up in earnest and, even in its so-called decadence, was strong enough to start a movement which was before long supported, with practical unanimity, by all British physicists and chemists. A deputation to Lord Salisbury followed, and a Committee, with Lord Rayleigh as Chairman, was appointed—

"To consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation: for the construction and preservation of standards of measurement: and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes—and to report whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost."

The Committee asked various scientific and technical institutions to nominate witnesses, and the evidence thus collected was very interesting and almost entirely in favour of the scheme. The views of those who approached the subject primarily as students of pure science are well known to the readers of NATURE; but it is satisfactory to note that they were warmly supported from the practical point of view by such men as Sir Bernhard Samuelson, Sir William Anderson, Sir Lowthian Bell, Mr. Crompton, Mr. Preece and others directly connected with industry and technology. The number of questions suggested as those on which useful work might be done was indeed almost overwhelming, and the Committee lay stress on the fact that one of the chief functions of the Governing Body would be to select the most important of the various problems with which they might deal. We agree with the opinion of the Committee that a strong Governing Body would arrive at a solution of this difficulty.

The Committee had further to consider the relations between the proposed institution, the Standards Department, and the Electrical Standardising Laboratory of the Board of Trade. They wisely decided that the new institution ought not to be under a Government Department, and as the Board of Trade has statutory powers with respect to the standards, this decision precludes a fusion between the Standards Department and the new Laboratory. It is, however, suggested that the relations between the two should be very close, that the Permanent Secretary of the Board of Trade should be *ex officio* a member of the Governing Body, which "should be consulted by the Standards Office and the Electrical Standardising Department of the Board of Trade upon difficult questions that may arise from time to time or as to proposed modifications or developments."

It is not, however, proposed to found a brand new institution. "In the opinion of the Committee the principles which underlie the proposal for the establishment of a National Physical Laboratory have been tested on a comparatively small scale at the Kew Observatory with the most satisfactory results."

The Committee therefore propose the extension of the Kew Observatory, and as that institution is controlled by the Royal Society it naturally follows that its management when enlarged and developed should remain in the same hands. A considerable change is, however, contemplated in the constitution of the Governing Body. Representatives of industry are to be added, and it is stipulated particularly that these should not necessarily be selected from among the Fellows of the Royal Society.

The plan thus sketched out seems reasonable and practical, and it is to be hoped that the Government will give effect to it.

If it does, and if the Royal Society consent to play the part assigned to it in the Report, the Council will undertake a grave responsibility and enjoy a great opportunity. Much will depend upon the start.

Nothing is said in the report of the Committee as to the funds which would be wanted to carry out the scheme they propose. The form which it ultimately assumes must depend upon whether the Government subvention is large or small. It is, we suppose, improbable that the new institution, if founded, will at first be on the same scale as the Reichsanstalt at Berlin. The question as to whether that institution is not too magnificent has in fact occurred to many of those who have seen it.

No one has ever accused the Kew Observatory of too lordly buildings or too lavish an equipment. As the central thermometric station, it has been hampered by the fact that it has not possessed the apparatus or the means to establish direct comparisons with the gas thermometer. We believe that this difficulty is about to be overcome by the generosity of Sir Andrew Noble who is presenting the necessary installation to the Observatory. But though in this and in other respects it has failed in the past to reach the level of its modern rivals, Kew has been useful both to industry and science. This is proved by its financial success. With a modest endowment of 470*l.* a year and the use of a Government building, the Committee make about 2000*l.* a year in fees, and the average receipts increased in the last five years about 25 per cent. over those in the earlier half of the decade. If a specific example of its operations be needed, it is sufficient to cite the fact that, unsolicited by the trade, Kew established a system of trials for watches, in which the leading makers now eagerly compete, and which they confess has improved the standard of their work.

The more scientific side of the functions of the Observatory is illustrated both by its magnetic work and by the fact that the Committee is now employing a gentleman to compare the platinum thermometer over a wide range with the gas thermometer at the Bureau des Poids et Mesures at Paris. What is wanted is the multiplication of operations such as these, together with the systematic determination of selected physical constants. With larger funds such results could be obtained, and there is no reason to fear that with a carefully chosen Committee, a good organisation, and the best Director that can be secured, the National Physical Laboratory would in due time take its place among the great scientific institutions of Europe, and would forge another link in the chain which binds science and industry together.

EXPERIMENTAL PHYSICS.

Lehrbuch der Experimental-Physik. Von Eduard Riecke. Zweiter Band, Magnetismus, Elektrizität, Wärme. (Leipzig: Verlag von Veit und Comp., 1896.)

IN NATURE for August 20, 1896, we reviewed the first volume of this work, and there stated what seemed to us to be its most notable features. The second volume strikes us as being even better than the first: the author, at any rate, seems to move in the subjects here treated with still more grace and freedom.

The treatment of the subjects is clear, and, so far as we have seen, always accurate, though the methods adopted are not always the newest. Perhaps, it may be argued, they are none the worse for that. However, in one or two places, there are described at some length various pieces of apparatus which hardly deserve a place in a modern book on electricity. An electrician may, for example, know nothing of the "unit jar," and not be a whit the worse. Yet Prof. Riecke gives "Ein vollständiges Bild von der Konstruktion der Massflasche"!

Dielectric action is illustrated by well-chosen and instructive diagrams. The theory described is one precisely analogous to that of magnetic induction and magnetic force, in which the medium is supposed to be made up of polarised molecules, the opposite charges of which act at a distance like other electric charges; while the electric induction is defined as the electrostatic force in a crevasse at right angles to the polarisation, and the electric force as the electrostatic force in a cylindrical hollow along the lines of polarisation. Thus we have in electricity, as in magnetism, the equation

$$\mathfrak{B} = \mathfrak{F} + 4\pi\mathfrak{J}.$$

Here a distinction is drawn between the true and the free distribution on the plate of a condenser, a mode of discussing the external action of the condenser which is supplemented by an all too short account of the Maxwellian view of the subject.

Prof. Riecke gives at p. 23 a simple construction for finding the direction of a magnetic line of force at any point P. Draw to the point a line CP from the centre C of the magnet, and find a point Q such that $CQ = \frac{1}{3}CP$. Draw from Q a perpendicular QR to CP, meeting the magnetic axis in R. RP is the direction of the line of force at P. It ought to be stated in the text that this construction, which is easily derivable from the polar equation $r = c \sin^2\theta$ of the line of force, is only applicable to the case of an infinitely short magnet; that is, it can only be applied for an ordinary bar magnet when the distance CP is very great in comparison with the length of the magnet.

The subject of electromagnetism is fully dealt with so far as the magnetic action of a current element, and the mutual force between two current elements are concerned. The law of Laplace (which was also given by Savary and by Ampère) that the magnetic force produced by a current γ in an element C of a circuit of length ds at a point P at distance r from the element and making an angle θ with CP is $\gamma ds \sin\theta / r^2$, and acts at right angles to the plane of the element and P, is first stated and used for the ordinary applications. Then from that, by the principle of action and reaction, is obtained the electromagnetic force on a current element γds in a field of intensity H, making an angle θ with the element is $\gamma H\, ds \sin\theta$. It is not noticed here, however, that taking the magnetic *action* of an element of current to be as stated in Laplace's formula, the *reaction* must exist in the same line as the action, and hence to get the electromagnetic force on each element the reaction must, after the method of Poinsot, be reduced to a force on the element and a couple.

All these laws of action of elements however are, it should be more emphasised, incapable of absolute demonstration. It is impossible to experiment with elements, and so settle the question, and no confirmation obtained by arriving at the observed actions of complete currents is proved in the least, inasmuch as the addition to the action of an element of any term, which integrated round the circuit gave a zero result would give another law, equally valid so far as the evidence goes. The same point requires mention again later when Ampère's law of the mutual action of two currents is discussed. It seems therefore to be demonstrably certain that in the ordinary theory of circuits it is impossible to arrive at a unique law of the mutual action of elements. Yet time is still wasted on the search for it.

Notwithstanding the narrow limits of the book as compared with many other Lehrbücher, Prof. Riecke has succeeded in compressing an immense amount of valuable matter into his chapters on electricity and magnetism. Of course the pages are large and well filled, and there is far more than would be contained in an English book of the same number of pages, but the author has succeeded wonderfully in contriving to give an account in so much detail of electro-optics, including the electromagnetic theory of light, and of dynamo-electric machinery.

The final chapter, Elektrochemie, Electrolyse, contains a fair discussion of the motion of ions, of electrolytic dissociation, winding up with a sketch of the energy theory of the voltaic cell.

The final part of the second volume deals with heat, and here again, in 130 pages, the author effects quite a marvel of condensation. Temperature, expansion, the air thermometer, all are soundly and clearly treated, and there is an absence of the terrible confusion about scales of the mercury and air thermometers which is so common. For example, we came across again the other day the statement that air is an excellent thermometric substance because its expansion is so *uniform*. The same thing is generally claimed in the same books for mercury, and the authors never seem to think that this uniformity is not absolute, but must be relative to some standard. They do not perceive that the standard they set up is really the expansion of the mercury itself in the thermometer. Here, however, there is no such nonsense.

The third book of this part deals with thermodynamics, and we must enter our protest once more against the mode of treatment adopted for absolute temperature. As is usual in German and French treatises temperature is first defined by the so-called law of gases, and then based on the hypothetical something called a perfect gas. Then that notion of temperature is carried into the discussion of the indicator diagrams given by Carnot's engine. Of course if a perfect gas is properly and clearly defined the discussion *can* be made logically consistent, though in what seems a forced and unnatural way; and Prof. Riecke is careful to state, though not quite all at one place, what the properties of his perfect gas are.

The true method is to define absolute temperature by means of a perfect engine, so as to get a scale independent of the properties of any known substance, and then Joule and Thomson's experiment becomes a comparison of the scales of different gas thermometers with the absolute scale, that is a test of the perfection of the gases. So far as we have been able to see, the name of Thomson is not mentioned in this section of the work!

In taking leave of this treatise we wish to say that students owe much to Prof. Riecke for giving them a readable, not too abstruse, and yet thoroughly sound and fairly full discussion of the elements of physics. To many German students who have not time to struggle through the larger treatises this book must be very welcome. A. GRAY.

A NEW DEPARTURE BY THE RAY SOCIETY.

The Tailless Batrachians of Europe. Part II. By G. A. Boulenger, F.R.S. (London: The Ray Society, 1898.)

WE recently reviewed under the above heading the first part of the above-mentioned work, which will become classical among popular treatises upon zoology, and the second part, following so close upon it, calls for nought but the highest admiration. In the 131 pages which compose its body, the Bufonidæ, Hylidæ, and Ranidæ, are treated in a manner uniform with the contents of the first volume, with which it is serially paged. There are 14 plates, of which 10 are coloured, 4 maps, and 44 text illustrations, all of the same excellence as in the first part; and the whole work well-nigh challenges criticism, it being praise sufficient to remark that it is its author's. Although the pages deal professedly with European animals, their value is materially enhanced by the recognition of the world-wide distribution of these, with especial reference to local varieties—as, for example, the Japanese and Chinese Bufones. The difficult topic of the racial varieties of the Ranidæ is for the first time handled in popular terms, the author giving the results of his ripe experience in a concise tabular form which will be of the greatest use to both the wayside and professed naturalist. Nor is the experimental aspect of the study neglected, and concerning this, in his disproof of the Fischer-Sigwart hypothesis (p. 311), the author once again displays a commendable enthusiasm and love of science for its own sake which cannot fail to exercise the healthiest influence upon the reader's mind. Equally encouraging is his frequent allusion to the work of the dillettanti, not a few among his critical observations and records as to geographical distribution and breeding period being culled from the pages of journals and the publications of local Natural History Societies, which the too academic critic might be apt to ignore. Under this head the incorporation of observations like those of Mr. Norman Douglass is deserving especial comment, as furnishing encouragement to the mere lover of nature and those content to seek our familiar creatures in localities in which they are unknown, and as bringing to these persons a full assurance that their efforts do not pass unnoticed by the leading masters of their craft. To the popular mind, the record of a toad's attempt to swallow a viper, and of the edible frog's more regular habit of snake capture, will especially appeal, as an interesting fact concerning the balance of nature.

The book concludes with an appendix of 16 pages; a bibliographical index of 13 pages; and an alphabetical index to the two parts. The appendix embraces a list of the specimens preserved in our National Museum at South Kensington, and to peruse this is to realise that the work is a popular commentary upon a collection unparalleled by that of any other museum in the world—a glorious possession of the British race. With this at his command the author could not have achieved other than a great result, but still by no means the least conspicuous feature about it is the stamp of his own individuality and personal influence which it bears. His book is worthy this unique material, and the best endeavours of all concerned in its accumulation; and while congratulating the Ray Society upon the success of their new departure, we earnestly hope that its executive will forthwith consider the advisability of making corresponding and ample provision for a companion work on the Batrachia Caudata, regarding that as at present the object most deserving their support, and most worthy their old-established reputation as pioneers in the popularisation of biology.

There are a few trivial matters of terminology in the present volume, such as the usage of the words "hand," "sternum," and "anus," and one or two expressions of orientation, to which exception might be taken; but these are altogether trivial where all else has been so nobly done.

OUR BOOK SHELF.

Morality independent of Obligation or Sanction. By M. Guyau. Translated from the French (second edition) by Gertrude Kapteyn. Pp. xii + 215. (London: Watts and Co., 1898.)

IN the twilight of gods and systems has naturalism any word as to the conduct of life? The author of "The Irreligion of the Future" feels that the scientific spirit in its revolt can rest in no optimism theological or teleological, while, discounting pessimism of temperament as simply the symptom of unfitness of life, the pessimism put forward as a general solution can be shown to be bound up with psychological illusion and is negatived by the will to live. If the systems afford us no certitude, and we cannot accept the anodyne of faith, what shall a spirit which doubts all that it may, and finds its chief probabilities in the indifference of nature and the relativity of knowledge, maintain as to the problems of that life which still goes on? Is it possible, upon the positive basis of facts which we cannot doubt, to found "a small house at the foot of the Tower of Babel," leaving the latter to rear itself to heaven, if it can, and not knowing whether in the end the new structure may not need its shelter?

As the conception of duty crumbles before analysis, its equivalents are to be found in the impulse to maintain and expand life in its productive fecundity, and in life the unconscious forces are as little negligible as the conscious. I can, therefore I must, overflow creatively into and upon other life, and in the spending is my gain. The ideas of expanding action are in themselves forces tending to realisation. Such expansion is necessarily social and even self-sacrificing. The struggle for existence, if it takes a purely egoistic direction, as in the case of violence, results in outward limitation and inner loss of equilibrium; while, supposing it to take the risk and, what the plain man means by, the responsibility of speculation or action, it realises the actual ideal of the moment, the hope which has not despaired of the commonweal. Thus morality without obligation is the outcome of naturalism. The so-called sanctions of morality are in part illusory, and are never wholly sanctions. The physical and physiological have no regard to intention. Remorse is not necessarily in the direction of morality. Punishment is justified only from the point of view of social defence, defence being the reaction upon attack which alone of our instincts does not lose force under the solvent of conscious analysis. We cannot substitute sanctions for obligation. The practical conclusion is a gospel of work and social fecundity: the theoretical that we stand, as it were, on the deck of some great ship lost between sky and water, and left to make what port it can; rudder there never was. But here the practical intervenes again. We will risk our all on our hopes. The rudder is still to make. "This is a great task; and it is our task." H. W. B.

Th. Thoroddsen, Geschichte der Isländischen Geographie. Vorstellungen von Island und seines Natur, und Untersuchungen darüber in alter und neuer Zeit. Autorisierte Uebersetzung von August Gebhardt. Vol. I., 1897; vol. II., 1898. Pp. xvi + 238, and xvi + 384. (Leipzig: B. G. Teubner.)

THESE volumes deal with the intellectual and social history of Iceland from the earliest times to the middle of the eighteenth century, and are by no means restricted to the geographical conditions of the island. Dr. Thoroddsen wrote in Icelandic and designed his book for his own countrymen, who remain in many ways one of the most cultured, at any rate of the most reading, peoples of Europe. He has spent most of his life in the detailed study of the geology of Iceland, on which he has written many monographs of great value, and now he is publishing the results of researches in a different direction, which have involved much searching of the archives of Iceland and Copenhagen; a great part of the text being derived from MSS. which have never before been printed.

The translator appears to have done his work with care and discrimination, but it must have been an unusually arduous task, as the old documents cited were in archaic Icelandic very difficult to render into modern German; and Dr. Gebhardt has endeavoured to preserve their flavour by imitating the contemporary German style and spelling when translating them.

The work is arranged chronologically, beginning with a discussion of the first reference to Iceland in classical writings, and proceeding to the first colonisation by Irish monks, the second by Norse exiles, the Golden Age of Icelandic discovery which followed, and the subsequent development of the most learned literary society in Europe. The mediæval accounts of Iceland are then discussed; but here the foreign reader is at a disadvantage, as he does not occupy the standpoint of the Icelander for whom the book was written, and loses much of the humour of the various misrepresentations of fact. The story of the narrow escape which Iceland made from becoming an English colony in the fifteenth century, when it was the great fishing ground for Bristol and Scarborough smacks, and the manner in which German commercial interests triumphed, has special interest for English readers. An account of the renaissance in Icelandic literature after the Reformation completes the first volume. The second volume deals largely with superstitions and witchcraft in the sixteenth and seventeenth centuries; and gives details of the first native descriptions of the country and the first surveys of Iceland, as well as recounting the services of Icelanders to science in general. These were, however, of no very great moment, and by no means so interesting to read of as the highly developed system of magic and witchcraft for which Iceland was famous in the preceding century.

An island of any sort is a fascinating thing to explore and to describe. It presents possibilities of completeness denied to countries which form part of a continent, and Dr. Thoroddsen has given his countrymen a book to study and to think over. For the sake of the foreign reader we hope that on the completion of the work he will himself retell the story in one handy volume, written with the object of making outsiders acquainted with Iceland and its people. H. R. M.

The Telephone. Outlines of the Development of Transmitters and Receivers. By Prof. William J. Hopkins. Pp. ix + 83. (New York and London: Longmans, Green, and Co., 1898.)

A CLEAR and connected explanation of the principles underlying the action and the design of telephone transmitters and receivers is given by Prof. Hopkins in this volume. The work is by no means exhaustive; indeed, men engaged in practical telephone construction may object that it is not full enough to be of real service. But as a general survey, for the instruction of students of telephony, the book contains a distinct view of the subject, into which details can be worked later on. The book begins with a chapter on the analysis of vibrations of sounding bodies. Following this is a short account of Reis's and Bell's telephones; and then come chapters on the development of transmitters, early successful types of transmitter, the results of systematic investigations upon transmitters of various types, granular transmitters, magneto instruments, and the design of receivers. This outline is sufficient to show that the volume provides students of practical electricity with a good view of telephone construction. The text is elementary enough to be read with interest by the general public.

Mathematical Examination Papers for Use in Navy Classes in Schools. By the Rev. J. L. Robinson, M.A. Pp. vii + 143. (London: Rivingtons, 1898.)

THIS collection of examination questions in arithmetic, algebra, geometry, mixed mathematics (including elementary trigonometry), and mechanics, and geometrical riders, will be found of real service by teachers preparing candidates for admission to naval cadetships of the Royal Navy. The student who works through the questions will be able to sit for the examination with an easy mind.

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.*]

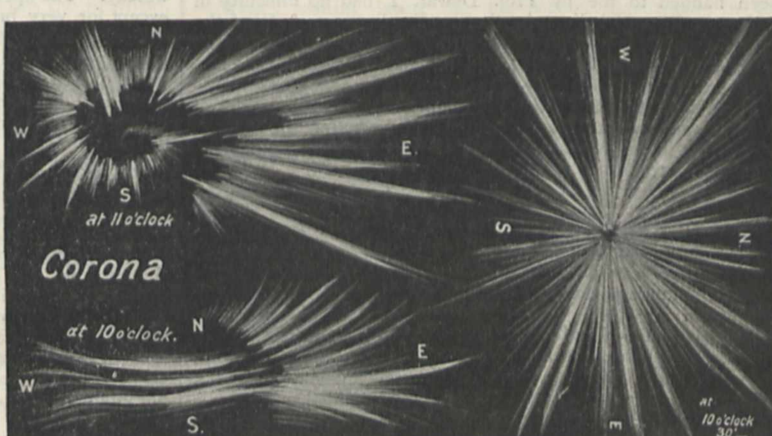
The Aurora Borealis of September 9.

I HAVE read, with much interest, in NATURE of September 15, the article concerning the aurora borealis of September 9, and it may be of interest to your readers to know that this

beautiful phenomenon displayed its splendours the same evening in all parts of Finland territory.

On that day I had the good fortune to see it in Helsingfors, from its earliest beginning to its end, in a clear, perfectly cloudless sky, and a calm and transparent air. These favourable conditions enabled me to sketch the principal movements of it, and I send you herewith a copy of the drawing I made.

The aurora was not only one of the most splendid that has been seen, but also that has appeared in our latitude for a long series of years. It began a little before 9 o'clock, and at 10 arrived at its maximum brilliancy, a state in which it, ever changing, remained till 11 o'clock, displaying the whole time an exceedingly beautiful brightness in all its parts.



The display began with a very bright arc in the north, but this very soon disappeared, while at the same moment exceedingly brilliant streamers extended at once up from the western and eastern horizons, sending immense columns to the zenith, and taking the shape of a colossal arc arching the whole sky from horizon to horizon. Masses of light flowed from both sides to the zenith, where they seemed to disappear. At 10 o'clock the great arc was interrupted on both sides by a dark region, the bright streamers remaining only on opposite horizons; but in the same moment a corona of the highest splendour appeared in the zenith, consisting of three nearly parallel streamers, stretching from west to east, and ending towards the west in the dark space, and towards the east in a beautiful fan of light. Half an hour later the corona took the shape of an immense dome, the ribs and columns of which stood around all parts of the horizon. The whole visible sky at that moment presented one single enormous dome of indescribable beauty. The brightest columns of this dome were to the west and to the east, those to the north were much less bright, and the columns to the south were scarcely visible. From every part of this dome streamers of light, without interruption, flowed up to the zenith.

At 11 o'clock, when the dome suddenly disappeared, the corona took the shape of a luminous spiral-ring, sending short but very bright streamers in all directions, especially to the east. This latter formation was surrounded by quite black spaces of sky, which made the luminous phenomena look more beautiful.

Meanwhile, in the northern part of the sky, the aurora took the shape of ever-changing columns, and long, sometimes spiral and undulating bands, which twice, in the north-west and in the north-east, doubled, resembling curtains hanging one over the other.

A little after eleven I saw in the north a very strange formation of aurora; three vertical columns in their upper part were crossed by a bright horizontal streamer, extending nearly from north-west to north-east.

Soon after 11.30 the aurora began to vanish everywhere, and, in a very marked manner, took more and more the aspect of some luminous shapeless cloud. After 12 o'clock all traces of columns and streamers disappeared, and at 1 o'clock nothing more of the phenomenon was to be seen.

N. KAULBARS.

Helsingfors, September 28.

Fourier's Series.

IN a letter to NATURE of October 6, Prof. Michelson, referring to the statement that a Fourier's series can represent a discontinuous function, describes "the idea that a real discontinuity can replace a sum of continuous curves" as "utterly at variance with the physicists' notions of quantity." If, as this seems to imply, there are physicists who hold "notions of quantity" opposed to the mathematical result that the sum of an infinite series of continuous functions may itself be discontinuous, they would be likely to profit by reading some standard treatise dealing with the theory of infinite series, such, for example, as Hobson's "Trigonometry," and the paper by Sir G. Stokes quoted on p. 251 of that work.

Prof. Michelson takes a particular case. He appears to find a difficulty in the result that the sum of the series

$$y = 2[\sin x - \tfrac{1}{2}\sin 2x + \tfrac{1}{3}\sin 3x - \ldots]$$

is equal to x when x lies between $-\pi$ and π, is equal to $-2\pi + x$ when x lies between π and 3π, and so on, and further is equal to zero when x is $-\pi$, or π, or 3π, and so on.

With the view of stating his difficulty simply, he has tried to sum this series, and the series obtained from it by differentiating its terms, for values of x of the form $\pi + \epsilon$, where it appears to be meant that ϵ is positive and less than 2π.

The series (thus obtained) for y and dy/dx are given by the equations

$$-\tfrac{1}{2}y = \sin\epsilon + \tfrac{1}{2}\sin 2\epsilon + \tfrac{1}{3}\sin 3\epsilon + \ldots + \frac{1}{n}\sin n\epsilon + \ldots$$

$$-\tfrac{1}{2}\frac{dy}{dx} = \cos\epsilon + \cos 2\epsilon + \cos 3\epsilon + \ldots + \cos n\epsilon + \ldots$$

Of the first series Prof. Michelson says: "This series increases with n until $n\epsilon = \pi$. Suppose therefore $\epsilon = k\pi/n$, where k is a small fraction. The series will now be nearly equal to $n\epsilon = k\pi$, a finite quantity even if $n = \infty$.

"Hence the value of y in the immediate vicinity of $x = \pi$ is not an isolated point $y = 0$, but a straight line $-y = nx$."

Of the second series he says that it "is nearly equal to n for values of $n\epsilon$ less than $k\pi$."

Neither of these statements is correct. The sum of the first series can be proved to be $\frac{1}{2}(\pi - \epsilon)$ when ϵ lies between 0 and 2π, and $-\frac{1}{2}(\pi + \epsilon)$ when ϵ lies between 0 and -2π, and it is zero when $\epsilon = 0$. The sum of n terms of the second series does not approach to any definite limit, as n is increased indefinitely; nor does the difference between the sum of this second series to n terms and the number n tend to zero or any finite limit, but the ratio of the sum to n terms and the number n tends to the definite limit zero as n is increased indefinitely.

The processes employed are invalid. It is not the case that the sum of an infinite series is the same as the sum of its first n terms, however great n is taken. It is not legitimate to sum an infinite series by stopping at some convenient nth term. It is not legitimate to evaluate an expression for a particular value of x, *e.g.* $x = \pi$, by putting $x = \pi + \epsilon$ and passing to a limit; to do so is to assume that the expression represents a continuous function. It is not legitimate to equate the differential coefficient of the sum of an infinite series to the sum of the differential coefficients of its terms; in particular the series given as representing dy/dx in the example is not convergent.

Lastly, Prof. Michelson says "it is difficult to see the meaning of the tangent if y were an isolated point." The tangent, at a point, to a curve, representing a function, has of course no meaning, unless the function has a differential coefficient, for the value corresponding to the point; and a function which has a differential coefficient, for any value of a variable, is continuous in the neighbourhood of that value.

St. John's College, Cambridge, October 7. A. E. H. LOVE.

Helium in the Atmosphere.

THE letter of Mr. Baly in your issue of last week, corroborating the statement of Friedländer and Kayser that helium is a constituent of the atmosphere, induces me to put on record a further confirmation of the accuracy of this observation. Having had the opportunity, on June 20 last, of examining samples of the more volatile portions from liquid air, which had been handed to me by Prof. Dewar, I had no difficulty in seeing the lines of helium in them. Further, a sample of the helium separated by Prof. Dewar from Bath gas (following the discovery of Lord Rayleigh) undoubtedly contained the substance called neon.

In giving these facts I am only confirming the observations of Prof. Dewar given to me in letters accompanying the samples of gas. WILLIAM CROOKES.

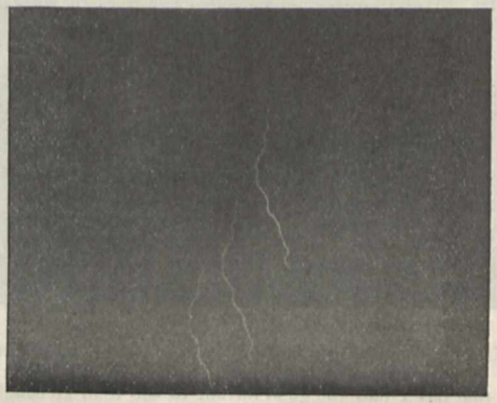
October 11.

Triplet Lightning Flash.

AT the suggestion of Lord Kelvin, I send you the enclosed photograph of a triplet lightning flash which was taken during a recent thunderstorm at Whitby, and under the following conditions.

The flash must have been about two miles distant (out at sea). The focus of the camera lens was 8 inches; the aperture, f/64; the plate, Ilford Empress. The camera was not stationary, but was purposely oscillated by hand. It was intended that its axis should describe a circular cone, but from the photograph the path appears to have been rather elliptical. Each revolution occupied about 1/80 minute. From these rough data I estimate that the three flashes followed each other with a frequency of about 30 to 35 per second. They are identical in shape, but the top part of the lowest (left-hand) one is missing, and the bottom is screened. On the negative the centre flash is rather weaker than the other two. Each flash is sharply defined on the left edge and somewhat hazy on the right edge, due probably to the gradual cooling of the glowing gases, and showing that the lowest (left-hand) flash is the first of the three. The photograph also contains a faint image of a single flash. During this thunderstorm two other plates were exposed under the same conditions as the above, but no images were found on them. Possibly the lightning was too far off, and the aperture too small.

In view of the importance of obtaining more definite information about lightning, I would suggest that in the presence of a thunderstorm photographs similar to the above should be taken. Greater accuracy than was possible under the above conditions could be attained by rigging up the following simple contrivance. An ordinary bedroom looking-glass should be placed on a table in front of an open window facing the storm. The mirror should be inclined at any angle of 45°. The camera tripod, with its legs spread as wide apart as possible, should be placed on the table so that its centre is over the looking-glass. The camera, with its objective downwards, should be suspended from this centre by means of three strings, and should be made to swing in a circle by a gentle finger pressure close to the point of suspension. The period of revolution should be noted. Should any multiple flash imprint itself on the negative, it will now be possible to accurately measure the intervals of time, except



under the following conditions. If there are only two flashes, the radius of the circle described by the camera can only be guessed at. If the camera has described an ellipse, at least four lightning images are required to find its elements. A camera revolving on an axis passing through the objective would in some respects be more convenient to work with, but unless it is revolved by clock-work the time measurements would not be trustworthy. The aperture used by me, f/64, is probably too small except for very brilliant flashes; but if it is intended to allow several discharges to imprint themselves on one negative, a very large aperture will be found inconvenient because of the illumination of the landscape. The size of the aperture, rapidity of plate, and distance of each lightning flash should be noted to assist at forming some idea as to the heat generated.

C. E. STROMEYER.

Lancefield, West Didsbury, October 3.

The Centipede-Whale.

THE "Scolopendrous Millipede," which forms the subject for the epigrams of Theodoridas and Antipater, and to which Mr. W. F. Sinclair kindly called my attention (NATURE, vol. lvi. p. 470), seems to mean a being quite different from the "Centipede-Whale" which Ælian and Kaibara describe (see my letter, *ibid.*, p. 445); for the former apparently points to a huge skeleton of some marine animal, while the latter is an erroneous but vivid portrait of an animal actively swimming with numerous fins.

Major R. G. Macgregor, in his translation of the Greek Anthology (1864, p 265), remarks upon the "Scolopendrous Millipede" that the "word *millipede* must be understood rather in reference to the extreme length of the monster than to the number of its feet." However, it would appear more likely that, in this similitude of the animal remains to the Myriapod, the numerous articulations of the vertebral column as well as its length played a principal part, should we take for comparison the following description of an analogous case from a Chinese work (Li Shih, "Süh-poh-wuh-chi," written thirteenth century. Jap. ed., 1683, tom. x. fol. 6, *b.*):—"Li Mien, a high officer (ninth century), during his stay in Pien-Chau, came in possession of one joint of a monstrous bone, capable of the use as inkstone (*Yen*). A foreign tradesman who brought it from the South Sea stated it to be the vertebra of a centipede." Seeing that its use here alluded to is nowadays often repeated, we do not hesitate to conclude that this "vertebra of a centipede" was nothing other than the vertebra of a whale. A long series of the cetacean vertebræ, especially when it is separate from the skull yet remaining adhered with the fragments of the ribs, would, to the imagination of those crude folks, naturally furnish a ready sketch of a gigantic, marine centipede.

The "Centipede-Whale" of Ælian's and Kaibara's descriptions are very probably certain species of sharks with the habit of swimming one following another. The reason is that while the fantastic figure of a six-legged sea-serpent, that was cast up on the Orkney in 1808 and subsequently proved to be the shark *Selache maxima* (*Memoirs* of the Wernerian Nat. Hist. Soc., Edin., vol. i., Plate XI., 1811), forcibly reminds us of the "Centipede-Whale," pictured in Gesner's "Historia Animalium" (see my letter, *l.c.*) and in a Japanese work (Hirazumi, "Morokoshi Kimmôdzui," 1719, tom. xiv. fol. 6, *a.*), Tanigawa Shisei, the Japanese glossarist (1707–1776), mentions in his "Wakun-no-Shiori" (ed. 1887, 3rd ser., tom. xvi. fol. 8, *a.*) the "Centipede-Shark" (*Mukadezame*), which is doubtless identical with the "Centipede-Whale." That the manner of the natatory movements of some sharks—to which are attributable the words of Ælian, "idque conferri posse cum triremi instae magnitudinis, atque per multis pedibus utrinque ordine sitis, tanquam ex scalmis appensis, natare"—should suggest to the mind the active representation of a terrestrial centipede, is well evinced by the Japanese word *Mukadebune* (*i.e* Centipede-Boat), signifying a slender boat with many oars in pairs that have to be moved like the legs of a running centipede (mentioned in Yuasa, "Jôzan Kidan," 1739, tom. xv. fol. 12, *a.*).

An older description of such a fabulous creature in the Far East, occurs in the Chinese "History of the Sui Dynasty" (written seventh century, A.D.), and reads thus: "Chin-Lah (Cambodja) produces a fish named *Fu-Hu*, which resembles Mud-Eel (*Monopterus javanensis*, Lacépède, according to Möllendorff), but with the bill shaped like the parrot's, and has eight legs"

When we set apart the more or less allied stories of the Dragon (Chinese, *Lung*, and Japanese, *Tatsu*), which very probably originates in the phenomena of waterspout and whirlpool,[1] we hardly know from the Far Eastern sources anything like the Sea-Serpent stories so much in circulation in the West. In the Far East, indeed, the Sea-Serpent seems to have totally given place to the Sea-Centipede, both having the identical, diverse origins—the back-bone of a whale, the sharks, and some Cephalopods (*cf.* "Encyc. Brit.," ninth ed., vol. xxi. pp. 608–610, and my letter, *l.c.*). Thus, in China, there prevails a long-established belief in the existence of huge centipedes in the South Sea, very valuable for their flesh and skin, the former tasting like prawn and much superior to beef, and the latter being useful for making drum.[2]

Turning to Japan, we read in the "Konjaku Monogatari" (written by Minamoto-no-Takakuni in the eleventh century, ed. Izawa, tom. xv. fol. 2–7), a narrative of the seven anglers, who killed a centipede about 10 feet long, that came from amidst a wide sea to combat with a huge serpent, the master of an island. This story of the "Sea-Centipede" is perhaps a prototype of the later but far more popularised legend of Tawara Tôda's slaughter of a monstrous Myriapod, which, the tradition says, used to molest a dragon in Lake Biwa.[3]

KUMAGUSU MINAKATA.

7 Effie Road, Walham Green, September 17.

[1] For similar misconceptions current among the Arabs, *vide* "Encyc. Brit.," *l.c.*, p. 610.

[2] The first description of such a gigantic centipede occurs in a poem by Koh Hung (*circa.* 254–334 A.D.). In the year 745 a centipede was found drowned by sea-tide on a coast of Kwang-Chau, and a man was fortunate enough to secure 120 *kin* weight of edible flesh by opening its "claws" ("Yuen-kien-lui-han," 1701, tom. cdxlix. fol. 11, *a.*). Here, the said "claw" would seem no other than the shark's fin, which in recent times has become the article of commercial importance with the Chinese. Even in the Imperial Geography ("Ta-Tsing-i-tung-chi," tom. cccliv. fol. 19, *b.*), compiled so lately as the eighteenth century, a similar centipede is described as native to Anam, which Tanigawa (*l.c.*) happily identifies with his "Centipede-Shark."

[3] The latter story is first recorded in "Taiheiki" (written fourteenth century, lib. xv. ch. 3), although its hero flourished in the tenth century (for its brief account see Mr. E. Gilbertson's article in the *Trans. and Proc. Jap. Soc.*, London, 1898, vol. iv., part ii., p. 115). Kyokutei Bakin, in his "Shichiya-no-Kura" (1810, ch. v.), gives an exhaustive account of this tradition, but does not refer to the "Sea-Centipede" story quoted above.

The Moon's Course.

THE moon's unique course was not known, in J. Fergusson's time, to be so peculiar as it now appears; for only five other satellites were then known, but now we know twenty, and still no other that has a path always concave to the sun.

It arises, of course, from her being more pulled by the sun than by the earth. All the others are more pulled by their primaries than by the sun. The distance from our earth where she balances the sun is but 1/569th of the sun's. But the moon's mean distance is fully a 386th of the sun's. The distance from Jupiter where he balances the sun is a 33rd of his own. That from Saturn is over a 60th of his own distance. That from Uranus a 155th; from Neptune a 140th; but from Mars only a 1760th; and in every case their furthest satellites are much nearer. Our moon's form of path is quite unique in the universe, so far as known.

E. L. GARBETT.

25 Claremont Square, London, N., October 10.

A Simple Method of Making Light Mirrors.

THE following description of a simple and inexpensive method of making optically perfect mirrors for galvanometers and similar instruments will, I think, be of interest to many of your readers.

Strips of French plate-glass, about 5 mm. thick and 20 mm. long, are well silvered and carefully polished with rouge. The silvered strip is placed upon edge on a flat stone or other firm support, and a light blow is struck with the edge of a hammer a little distance back from the silvered face. If the blow is well directed, a chip of glass of circular or elliptical form will be broken out. The nearer the edge the blow is struck the thinner the mirror will be. Of course not every blow will produce a good mirror, but with a little practice a strip 10 centimetres long should yield a dozen good mirrors, of assorted weights and sizes, which may be cemented to a card and put away in a box for use as occasion requires. Since the silver surface is exposed, it will tarnish in time; but as the expense and trouble involved in making the mirrors is so slight, and the definition given by them when new is so perfect, one can afford to renew them once a year if necessary. The method of silvering mirrors given in the "Encyclopædia Britannica" gives a surface well adapted to this purpose.

CHARLES B. THWING.

Knox College, Galesburg, Illinois, September 17.

Animals and Poisonous Plants.

WHEN visiting lately the herbaceous department in the Royal Botanic Gardens, Regent's Park, I noticed that nearly all the berries had disappeared from the deadly nightshade, *Atropa belladonna*, the calyx being left untouched. The foreman of the herbaceous department told me that he believed they had been eaten by blackbirds, which are very active in the bushes; also that the seeds of *Datura stramonium* are eagerly devoured by mice. Can any of your readers confirm this statement of animals feeding on poisonous plants? In *Nature Notes* for October, I notice a statement of a report that wild rabbits feed on the leaves of the belladonna.

ALFRED W. BENNETT.

Crannoges in Estuaries.

REFERRING to the notices on this subject in NATURE of September 15 and 29, I beg to say that, in 1879, I discovered a crannoge constructed on a bed of peat, below high-water mark, in Ardmore Bay, Co. Waterford. It was at the mouth of a small stream.

The diameter of the enclosure was about 100 feet. It was surrounded by a double fence of massive piles, apparently sharpened with the stone axe. The interior contained mortised beams and cleft panels of the dwelling, and portions of the wattled partitions, traces of which covered the enclosed area in the form of pointed stakes whose ends remained in the peat.

The kitchen midden contained bones of horse, ox, goat, pig, and red deer, the usual bill of fare found in the raths of the country.

A paper on this crannoge was published in the *Proceedings* of the Royal Irish Academy, December 1880, and the site has been visited by Prof. Boyd Dawkins. It is covered by every tide, and the crannoge is now almost obliterated.

Cappagh, Fermoy, October 1.

R. J. USSHER.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.[1]

I.

THE two addresses by my colleagues Profs. Judd and Roberts-Austen have drawn attention to the general history of our College and the details of one part of our organisation. I propose to deal with another part, the consideration of which is of very great importance at the present time, for we are in one of those educational movements which spring up from time to time and mould the progress of civilisation. The question of a Teaching University in the largest city in the world, Secondary Education, and so-called Technical Education are now occupying men's minds.

At the beginning it is imperative that I should call your attention to the fact that the stern necessities of the human race have been the origin of all branches of science and learning; that all so-called educational movements have been based upon the actual requirements of the time. There has never been an educational movement for learning's sake; but of course there have always been studies and students apart from any of those general movements to which I am calling attention; still we have to come down to the times of Louis Quatorze before the study of the useless, the *même inutile*, was recognised as a matter of national concern.

It is perhaps the more necessary to insist upon stern necessity as being the origin of learning, because it is so difficult for us now to put ourselves in the place of those early representatives of our race that had to face the problems of life among conditionings of which they were profoundly ignorant: when night meant death; when there was no certainty that the sun would rise on the morrow; when the growth of a plant from seed was unrecognised; when a yearly return of seasons might as well be a miracle as a proof of a settled order of phenomena; when, finally, neither cause nor effect had been traced in the operations of nature.

It is doubtless in consequence of this difficulty that some of the early races have been credited by some authors with a special love of abstract science, of science for its own sake; so that this, and not stern necessity, was the motive of their inquiries. Thus we have been told that the Chaldæans differed from the other early races in having a predilection for astronomy, another determining factor being that the vast plains in that country provided them with a perfect horizon.

The first historic glimpses of the study of astronomy we find among the peoples occupying the Nile Valley and Chaldæa, say 6000 B.C.

But this study had to do with the fixing of the length of the year, and the determination of those times in it in which the various agricultural operations had to be performed. These were related strictly to the rise of the Nile in one country and of the Euphrates in the other. All human activity was in fact tied up with the movements of the sun, moon and stars. These, then, became the gods of those early peoples, and the astronomers, the seers, were the first priests; revered by the people because as interpreters of the celestial powers they were the custodians of the knowledge which was the most necessary for the purposes of life.

Eudemus of Rhodes, one of the principal pupils of Aristotle, in his History of Geometry, attributes the origin of geometry to the Egyptians, "who were obliged to invent it in order to restore the landmarks which had been destroyed by the inundation of the Nile," and observes "that it is by no means strange that the invention of the Sciences should have originated in practical needs."[2] The new geometry was brought from Egypt to Greece by Thales three hundred years before Aristotle was born.

[1] An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6.

[2] "Greek Geometry from Thales to Euclid," p. 2. (Allman.)

When to astronomy and geometry we add the elements of medicine and surgery, which it is known were familiar to the ancient Egyptians, it will be conceded that we are, in those early times, face to face with the cultivation of the most useful branches of science.

Now, although the evidence is increasing day by day that Greek science was Egyptian in its origin, there is no doubt that its cultivation in Greece was more extended, and that it was largely developed there. One of the most useful and prolific writers on philosophy and science who has ever lived, Aristotle, was born in the fourth century B.C. From him, it may be said, dates a general conception of science based on *observation* as differing from experiment. If you wish to get an idea of the science of those times, read his writings on Physics and on the Classification of Animals. All sought in Aristotle the basis of knowledge, but they only read his philosophy; Dante calls him "the Master of those who know."[1]

Why was Aristotle so careful to treat science as well as philosophy, with which his master, Plato, had dealt almost exclusively?

The answer to this question is of great interest to our present subject. The late Lord Playfair[2] in a pregnant passage, suggests the reason, and the later history of Europe shows, I think, that he is right.

"We find that just as early nations became rich and prosperous, so did philosophy arise among them, and it declined with the decadence of material prosperity. In those splendid days of Greece, when Plato, Aristotle, and Zeno were the representatives of great schools of thought, which still exercise their influence on mankind, *Greece was a great manufacturing and mercantile community;* Corinth was the seat of the manufacture of hardware; Athens that of jewellery, shipbuilding and pottery. The rich men of Greece and all its free citizens were actively engaged in trade and commerce. The learned class were the sons of those citizens, and were in possession of their accumulated experience derived through industry and foreign relations. Thales was an oil merchant; Aristotle inherited wealth from his father, who was a physician, but, spending it, is believed to have supported himself as a druggist till Philip appointed him tutor to Alexander. Plato's wealth was largely derived from commerce, and his master, Socrates, is said to have been a sculptor. Zeno, too, was a travelling merchant. Archimedes is perhaps an exception, for he is said to have been closely related to a prince; but if so, he is the only princely discoverer of science on record."

In ancient Greece we see the flood of the first great intellectual tide. Alas! it never touched the shores of Western Europe, but it undoubtedly reached to Rome, and there must have been very much more observational science taught in the Roman studia than we generally imagine, otherwise how account for Pliny, the vast public works, their civilising influence carried over sea and land from beyond Bab-el-Mandeb to Scotland? In some directions their applications of science are as yet unsurpassed.

With the fall of the Roman Empire both science and philosophy disappeared for a while. The first wave had come and gone; its last feebler ripples seem to have been represented at this time by the gradual change of the Roman secular studia wherever they existed into clerical schools, the more important of which were in time attached to the chief cathedrals and monasteries; and it is not difficult to understand why the secular (or scientific) instruction was gradually replaced by one more fitted for the training of priests.

It is not to be wondered at that the ceaseless strife in the centre of Europe had driven what little learning there was to the Western and Southern extremities where

[1] "Inferno," c. iv. 130 *et seq.*

[2] "Subjects of Social Welfare," p. 205

the turmoil was less—I refer to Britain and South Italy—while the exiled Nestorians carried Hellenic science and philosophy out of Europe altogether to Mesopotamia and Arabia.

The next wave, it was but a small one, had its origin in our own country. In the eighth century England was at its greatest height, relatively, in educational matters; chiefly owing to the labours of two men. Beda, generally called the Venerable Bede, the most eminent writer of his age, was born near Monkwearmouth in 673, and passed his life in the monastery there. He not only wrote the history of our island and nation, but treatises on the nature of things, astronomy, chronology, arithmetic, medicine, philosophy, grammar, rhetoric, poetry, music; basing his work on that of Pliny. He died in 735, in which year his great follower was born in Yorkshire. I refer to Alcuin. He was educated at the Cathedral School at York under Archbishop Egbert, and having imbibed everything he could learn from the writings of Bede and others, was soon recognised as one of the greatest scholars of the time. On returning from Rome, whither he had been sent by Eaubald to receive the pallium, he met Karl the Great, King of the Franks and Lombards, who eventually induced him to take up his residence at his Court, to become his instructor in the sciences. Karl (or Charlemagne) then was the greatest figure in the world, and although as King of the Franks and Lombards, and subsequently Emperor of the Holy Roman Empire, his Court was generally at Aachen, he was constantly travelling throughout his dominions. He was induced, in consequence of Alcuin's influence, not only to have a school always about him on his journeys, but to establish, or foster, such schools wherever he went. Hence it has been affirmed that "France is indebted to Alcuin for all the polite learning it boasted of in that and the following ages." The Universities of Paris, Tours, Fulden, Soissons and others were not actually founded in his day, but the monastic and cathedral schools out of which they eventually sprung were strengthened, and indeed a considerable scheme of education for priests was established; that is, an education free from all sciences, and in which philosophy alone was considered.

Karl the Great died in 814, and after his death the eastward travelling wave, thus started by Bede and Alcuin, slightly but very gradually increased in height. Two centuries later, however, the conditions were changed. We find ourselves in presence of interference phenomena, for then there was a meeting with another wave travelling westwards, and this meeting was the origin of the European Universities. The wave now manifested travelling westerly, spread outward from Arab centres first and finally from Constantinople, when its vast stores of Greek lore were opened by the conquest of the city.

The first wavelet justified Eudemus' generalisation that "the invention of the Sciences originated in practical needs," and that knowledge for its own sake was not the determining factor. The year had been determined, stone circles erected almost everywhere, and fires signalled from them, giving notice of the longest and shortest days, so that agriculture was provided for, even away from churches and the Festivals of the Church. The original user of geometry was not required away from the valleys of the Nile, Tigris and Euphrates, and, therefore, it is now Medicine and Surgery that come to the front for the alleviation of human ills. In the eleventh century we find Salerno, soon to be famed throughout Europe as the great Medical School, forming itself into the first University. And Medicine did not exhaust all the science taught, for Adelard listened there to a lecture on "the nature of things," the cause of magnetic attraction being one of the "things" in question.

This teaching at Salerno preceded by many years the study of the law at Bologna and of theology at Paris.

The full flood came from the disturbance of the Arab wave-centre by the Crusades, about the beginning of the twelfth century. After the Pope had declared the "Holy War," William of Malmesbury tells us, "The most distant islands and savage countries were inspired with this ardent passion. The Welshman left his hunting, the Scotchman his fellowship with vermin, the Dane his drinking party, the Norwegian his raw fish." Report has it that in 1096 no less than six millions were in motion along many roads to Palestine. This, no doubt, is an exaggeration, but it reflects the excitement of the time, and prepares us for what happened when the Crusaders returned; as Green puts it,[1] "the western nations, including our own, 'were quickened with a new life and throbbing with a new energy.' . . . A new fervour of study sprang up in the West from its contact with the more cultured East. Travellers like Adelard, of Bath, brought back the first rudiments of physical and mathematical science from the schools of Cordova or Bagdad. . . . The long mental inactivity of feudal Europe broke up like ice before a summer's sun. Wandering teachers, such as Lanfranc or Anselm, crossed sea and land to spread the new power of knowledge. The same spirit of restlessness, of inquiry, of impatience with the older traditions of mankind, either local or intellectual, that drove half Christendom to the tomb of its Lord, crowded the roads with thousands of young scholars hurrying to the chosen seats where teachers were gathered together."

Studium generale was the term first applied to a large educational centre where there was a guild of masters, and whither students flocked from all parts. At the beginning of the thirteenth century the three principal studia were Paris, Bologna and Salerno, where theology and arts, law and medicine, and medicine almost by itself, were taught respectively; these eventually developed into the first universities.[2]

English scholars gathered in thousands at Paris round the chairs of William of Champeaux or Abelard, where they took their place as one of the "nations" of which the great Middle Age University of Paris was composed.

We have only to do with the Arts faculty of this University. We find that the subject-matter of the liberal education of the Middle Age there dealt with varied very little from that taught in the schools of ancient Rome.

The so-called "artiens," students of the Arts faculty, which was the glory of the University and the one most numerously attended, studied the seven arts of the trivium and quadrivium—that is, grammar, rhetoric, dialectic and arithmetic, geometry, music, astronomy.[3]

This at first looks well for scientific study, but the mathematics taught had much to do with magic; arithmetic dealt with epacts, golden numbers, and the like. There was no algebra, and no mechanics. Astronomy dealt with the system of the seven heavens.

Science, indeed, was the last thing to be considered in the theological and legal studia, and it would appear that it was kept alive more in the medical schools than in the Arts faculties. Aristotle's writings on physics, biology, and astronomy were not known till about 1230, and then in the shape of Arab-Latin translations. Still it must not be forgotten that Dante learned some of his astronomy, at all events, at Paris.

Oxford was an offshoot of Paris, and therefore a theological studium, in all probability founded about 1167,[4] and Cambridge came later.

Not till the Reformation (sixteenth century) do we see

1 "History of the English People," I. 198.
2 See "Historie de l'Université de Paris." Crévier, 1791, *passim*.
3 Enumerated in the following Middle Age Latin verse:
"Lingua, tropus, ratio, numerus, tonus, angulus, astra."
4 "Universities of Europe in the Middle Ages," Rashdall, vol. ii. p. 344.

any sign of a new educational wave, and then we find the two which have had the greatest influence upon the history of the world—one of them depending upon the Reformation itself, the other depending upon the birth of experimental inquiry.

Before the Reformation the Universities were priestly institutions, and derived their authority from the Popes. The Universities were for the few; the education of the people, except in the various crafts, was unprovided for.

The idea of a general education in secular subjects at the expense of the State or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamt of, or rather, perhaps, one should say, the question was decided in the negative. In his day, however, his zeal first made itself heard in favour of education, as many are now making themselves heard in favour of a better education, and in 1524 he addressed a letter to the Councils of all the towns in Germany, begging them to vote money not merely for roads, dikes, guns, and the like, but for schoolmasters, so that all children might be taught; and he states his opinion that if it be the duty of a State to compel the able-bodied to carry arms, it is *à fortiori* its duty to compel its subjects to send their children to school, and to provide schools for those who without such aid would remain uninstructed.

Here we have the germ of Germany's position at the present day, not only in scientific instruction but in everything which that instruction brings with it.

With the Reformation this idea spread to France. In 1560 we find the States General of Orleans suggesting to Francis II. a "levée d'une contribution sur les bénéfices ecclésiastiques pour raisonablement stipendier des pédagogues et gens lettrés, en toutes villes et villages, pour l'instruction de la pauvre jeunesse du plat pays, et soient tenus les pères et mères, à peine d'amende, à envoyer les dits enfants à l'école, et à ce faire soient contraints par les segnieurs et les juges ordinaires."

Two years after this suggestion, however, the religious wars broke out; the material interests of the clerical party had predominated, the new spirit was crushed under the iron heel of priestcraft, and the French, in consequence, had to wait for three centuries and a revolution before they could get comparatively free.

In the Universities, or at all events alongside them, we find next the introduction, not so much yet of science, as we now know it, with its experimental side, as of the scientific spirit.

The history of the Collége de France, founded in 1531 by Francis the First, is of extreme interest. In the fifteenth century, the studies were chiefly literary, and except in the case of a few minds they were confined merely to scholastic subtleties, taught (I have it on the authority of the Statistique de l'Enseignement Supérieur) in barbarous Latin. This was the result of the teaching of the faculties; but even then, outside the faculties, which were immutable, a small number of distinguished men still occupied themselves in a less rigid way in investigation; but still these studies were chiefly literary. Among those men may be mentioned Danès, Postel, Dole, Guillaume Budé, Lefèvre d'Étaples, and others, who edited with notes and commentaries Greek and Latin authors whom the University scarcely knew by name. Hence the renaissance of the sixteenth century, which gave birth to the Collége de France, the function of which, at the commencement, was to teach those things which were not in the ordinary curriculum of the faculties. It was called the *Collége des Deux Langues*, the languages being Hebrew and Greek. It then became the *Collége des Trois Langues*, when the king, notwithstanding the opposition of the University, created in 1534 a chair of Latin. There was another objection made by the University to the new creation: from the commencement the courses were free; and this feeling was not decreased by the fact that around the celebrated masters of the Trois Langues a crowd of students was soon congregated.

The idea in the mind of Francis the First in creating this Royal College may be gathered from the following Edict, dated in 1545: "François, &c., savoir faisons à tous présents et à venir que Nous, considérant que le sçavoir des langues, qui est un des dons du Saint-Esprit, fait ouverture et donne le moyen de plus entière connaissance et plus parfaite intelligence de toutes bonnes, honnêtes, saintes et salutaires sciences. . . . Avons fait faire pleinement entendre à ceux qui, y voudraient vacquer, les trois langues principales, Hébraïque, Grecque, et Latine, *et les Livres esquels les bonnes sciences* sont le mieux et le plus profondément traitées. A laquelle fin, et en suivant le décret du concile de Vienne, nous avons piéça ordonné et establi en nôtre bonne ville de Paris, un bonne nombre de personnages de sçavoir excellent, qui lisent et enseignent publiquement et ordinairement les dites langues et sciences, maintenant florissant autant ou plus qu'elles ne firent de bien longtemps. . . . auxquels nos lecteurs avons donné honnêtes gages et salaires, et iceux fait pourvoir de plusieurs beaux bénéfices pour les entretenir et donner occasion de mieux et plus continuellement entendre au fait de leur charge. . . . &c."

The Statistique, which I am following in this account, thus sums up the founder's intention:—"Le Collége Royal avait pour mission de propager les nouvelles connaissances, les nouvelles découvertes. Il n'enseignait pas la science faite, il la faisait."

It was on account of this, more than on account of anything else, that it found its greatest enemy in the University. The founding of this new College, and the great excitement its success occasioned in Paris, were, there can be little doubt, among the factors which induced Gresham to found his College in London in 1574.

These two institutions played a great part in their time. Gresham College, it is true, was subsequently strangled, but not before its influence had been such as to permit the Royal Society to rise phœnix-like from its ashes, for it is on record that the first step in the forming of this Society was taken after a lecture on astronomy by Sir Christopher Wren at the College. All connected with them felt in time the stupendous change of thought in the century which saw the birth of Bacon, Galileo, Gilbert, Hervey, Tycho Brahe, Descartes and many others that might be named; and of these, it is well to remark, Gilbert,[1] Hervey and Galileo were educated in medical schools abroad.

Bacon was not only the first to lay down *regulæ philosophandi*, but he insisted upon the far-reaching results of research, not forgetting to point out that "*lucifera experimenta, non fructifera quærenda*,"[2] as a caution to the investigator, though he had no doubt as to the revolution about to be brought about by the ultimate application of the results of physical inquiry.

As early as 1560 the Academia Secretorum Naturæ was founded at Naples, to be followed by the Lincei in 1609, the Royal Society in 1645, the Cimento in 1657, and the Paris Academy in 1666.

From that time the world may be said to have belonged to science, now no longer based merely on observation but on experiment. But, alas! how slowly has it percolated into our Universities.

The first organised endeavour to teach science in schools was naturally made in Germany (Prussia), where, in 1747 (nearly a century and a half ago), Realschulen were first started; they were taken over by the Government in 1832, and completely reorganised in 1859, this step being demanded by the growth of industry and the spread of the modern spirit. Eleven hours a week were given to natural science in these schools forty years ago.

1 "William Gilbert, of Colchester, on the Magnet." Mittelag, p. x.
2 "Nov. Org.," l. 70. Fowler's Edition, p. 255.

Teaching the Teachers.

Until the year 1762 the Jesuits had the education of France almost entirely in their hands, and when, therefore, their expulsion was decreed in that year, it was only a necessary step to create an institution to teach the future teachers of France. Here, then, we had the École Normale in theory; but it was a long time before this theory was carried into practice, and very probably it would never have been had not Rolland d'Erceville made it his duty, for more than twenty years, by numerous publications, amongst which is especially to be mentioned his "Plan d'Education," printed in 1783, to point out, not merely the utility, but the absolute necessity for some institution of the kind. As generally happens in such cases, this exertion was not lost, for, in 1794, it was decreed that an *École Normale* should be opened at Paris, "ou seront appelés de toutes les parties de la République, des citoyens déjà instruits dans les sciences utiles, pour apprendre, sous les professeurs les plus habiles dans tous les genres, l'art d'enseigner."

To follow these courses in the art of teaching, one potential schoolmaster was to be sent to Paris by every district containing 20,000 inhabitants. 1400 or 1500 young men, therefore, arrived in Paris, and in 1795 the courses of the school were opened first of all in the amphitheatre of the Museum of Natural History. The professors were chosen from among the most celebrated men of France, the sciences being represented by Lagrange, Laplace, Haüry, Monge, Daubenton, and Berthollet.

While there was this enormous progress abroad, represented especially by the teaching of science in Germany and the teaching of the teachers in France, things slumbered and slept in Britain. We had our coal and our iron, our material capital, and no one troubled about our mental capital—least of all the universities, which had become, according to Matthew Arnold (who was not likely to overstate matters), mere *hauts lycées*, and "had lost the very idea of a real university,"[1] and since our political leaders generally came from the universities little more was to be expected from them.

Many who have attempted to deal with the history of education have failed to give sufficient prominence to the tremendous difference there must necessarily have been in scientific requirements before and after the introduction of steam power.

It is to the discredit of our country that we, who gave the perfected steam engine, the iron ship, and the locomotive to the world, should have been the last to feel the next wave of intellectual progress.

All we did at the beginning of the century was to found mechanics' institutions. They knew better in Prussia, "a bleeding and lacerated mass,"[2] after Jena (1806), King Frederic William III. and his councillors, disciples of Kant, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty money was found for the Universities of Kœnigsberg and Breslau, and Bonn was founded in 1818. As a result of this policy, carried on persistently and continuously by successive Ministers, aided by wise councillors, many of them the products of this policy, such a state of things was brought about that not many years ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany "a supremacy in Science comparable to the supremacy of England at sea."

But this position has not been obtained merely by founding new universities. To Germany we owe the perfecting of the methods of teaching Science.

I have shown that it was in Germany that we find the first organised science teaching in schools. About the year 1825 that country made another tremendous stride. Liebig demonstrated that science teaching, to be of value, whether in the school or the university, must consist to a greater or less extent in practical work, and the more the better; that book work was next to useless.

Liebig, when appointed to Giessen, smarting still under the difficulties he had had in learning chemistry without proper appliances, induced the Darmstadt Government to build a chemical laboratory in which the students could receive a thorough practical training.

It will have been gathered from this reference to Liebig's system of teaching chemistry, that still another branch of applied science had been created, which has since had a stupendous effect upon industry; and while Liebig was working at Giessen, another important industry was being created in England. I refer to the electric telegraph and all its developments, foreshadowed by Galileo in his reference to the "sympathy of magnetic needles."

Not only then in chemistry, but in all branches of science which can be applied to the wants of man, the teaching must be practical—that is, the student must experiment and observe for himself, and he must himself seek new truths.

It was at last recognised that a student could no more learn Science effectively by seeing some one else perform an experiment than he could learn to draw effectively by seeing some one else make a sketch. Hence in the German Universities the Doctor's degree is based upon a research.

Liebig's was the *fons et origo* of all our laboratories—mechanical, metallurgical, chemical, physical, geological, astronomical, and biological. J. NORMAN LOCKYER.

(*To be continued.*)

[1] "Schools and Universities on the Continent," p. 291.
[2] "University Education in England, France and Germany," Sir Rowland Blennerhassett, p. 25.

OPENING OF THE THOMPSON-YATES LABORATORIES AT UNIVERSITY COLLEGE, LIVERPOOL.

THE latest addition to the noble series of buildings now fast surrounding the old lunatic asylum in which University College, Liverpool, started work seventeen years ago is devoted to the Schools of Physiology and Pathology. The professorships in these subjects were endowed and equipped by the late Mr. George Holt some years ago; and now suitable laboratories, on a magnificent scale, have been erected by the generosity of the Rev. S. A. Thompson-Yates at a cost of nearly 30,000*l*.

The building is of Liverpool grey brick and Ruabon terra-cotta in the renaissance Gothic style. It is L-shaped, one wing extending towards the north, where it joins the pathological museum of the old medical school buildings, and the other towards the east, the entrance being at the angle where the wings join. There are three floors and a basement. The two upper floors are occupied by physiology, under Prof. Sherrington; and the ground floor and basement by pathology, under Prof. Boyce. A large lecture theatre, the fine staircase and halls, and a few other apartments for the use of students are common to the two departments. Simplicity of plan has been the aim of the architects (Messrs. A. Waterhouse and Son), and there has been little or no expenditure of space in corridors and passages. As some of the rooms are to accommodate large numbers of workers, and so require to be lofty, while others are the private studies of individuals where a high ceiling would mean waste of space, a free use has been made of the expedient of mezzanines, by which the smaller rooms have been interpolated between the floors. The lecture theatre is very completely fitted for lantern illustration, including the projection microscope, the chromoscope, the animatograph, the episcope and skiopticon, and also very perfect arrangements for the projection of the spectrum. The Physiological Department contains, in addition, large rooms for :—Chemical physiology with separate work-places for over fifty students, and fuller accommodation for about six research workers ; physical physiology enabling a class of more than thirty to carry out exercises on muscle and nerve at one time, each student's place being provided with electric light, water, gas, electric wire for supply of current, induction coil, electric battery, recording drum driven by fixed pulleys from the shafting running above the table, electric keys, and heliostat apparatus, &c. ; histology with accommodation for about eighty students, with adjoining preparation and store rooms ; also smaller chemical rooms, professor's private and photographic rooms, room for experiments in electro-physiology, and a smaller theatre for the demonstration of experiments. The Pathological Department has large rooms for :—Morbid histology with work-places for sixty students ; bacteriological work with suction and force pumps for filtering, a bacterial mill for pulverising bacteria, and a plentiful supply of steam at high pressure to conduct the various boiling operations. There are also rooms for chemical pathology, museum preparator's work, incubators at constant temperature, private experimental work, pathological diagnosis society, bacteriological work of the city, gas analysis, and the professors' private rooms. Briefly stated the special features of the pathological laboratories are the impervious opaline slabs covering the tops of the work-benches, and diminishing the risk of contamination and facilitating cleaning, the use of steam for boiling operations, a plentiful electric supply working the lamps and the numerous motors, and a specially high-pressure water supply, and lastly the refrigerator chamber. Throughout the Thompson-Yates laboratories are fitted up in the most complete and perfect manner, both for teaching and research ; and the favourable opinions which have been so freely expressed by the distinguished scientific visitors during the opening and following days may be briefly summed up in the quotation from Prof. Michael Foster's happy and stimulating speech at the banquet, that "they (the laboratories) produced two physiological effects—they took one's breath away, and they made one's mouth water."

The invitation from the Council and Senate of University College to the opening function was accepted by a large number of distinguished men of science and representatives of universities and medical schools from all parts of the country, including Lord Lister and Lord Kelvin, Earl Spencer and the Earl of Derby, the Bishops of Ripon, Carlisle, Chester and Liverpool, Prof. Virchow, Sir S. Wilks (President of the College of Physicians), the Vice-Chancellor of Cambridge University, Prof. M. Foster and Prof. Burdon Sanderson, the Presidents of the Royal College of Physicians and Surgeons of Edinburgh, Sir W. Turner, Sir W. Gairdner, Sir Douglas Galton, Sir A. Geikie, Sir J. Crichton Browne, Mr. R. B. Haldane, M.P., Mr. Justice Kennedy, Sir James Russell, Prof. Rutherford, Dr. Lauder Brunton, Captain Abney, Prof. Rücker, Prof. Poulton, Prof. Gotch, Prof. Kanthack, Sir R. Thorne Thorne, Prof. Schäfer, and many others. These guests, for the most part in their academic robes, walked in procession with the civic authorities, the University and College staff, forming a ceremonial that for stateliness, brilliance, and interest has probably never been equalled before in Liverpool.

The scientific and medical guests arrived in Liverpool on Friday, and that day and Sunday were given up to private hospitality and informal meetings at the College and elsewhere ; while Saturday, October 8, was the date of the University Degree ceremony and the formal opening of the new laboratories.

The University function was arranged to take place in St. George's Hall ; and there, in the presence of the Lord Mayor and Corporation, the staff, graduates and students of the University, the distinguished guests, and a large concourse of citizens of Liverpool, the honorary degree of Doctor of Science was conferred upon Lord Lister by Earl Spencer, the Chancellor of the Victoria University.

Lord Lister was presented for the degree by Dr. Richard Caton, Chairman of the Medical Faculty, and formerly Professor of Physiology in University College ; and both the Chancellor and Dr. Caton in their speeches drew attention to Lister's immortal life-work in the antiseptic methods of surgery, and to the benefits conferred thereby upon humanity and the lower animals.

After Lord Lister had been admitted to the degree by the Chancellor, and had signed the roll of graduates, the Principal of University College (Mr. R. T. Glazebrook, F.R.S.) made a statement as to the history of the medical school and of the erection of the new laboratories by Mr. Thompson-Yates. The generous donor himself was unable to be present, but a letter from him was read expressing good wishes.

Lord Lister then delivered a short address, for which a vote of thanks was proposed by the Lord Mayor of Liverpool, and seconded (in the absence of Lord Derby) by Mr. W. Rathbone, Vice-President of the College.

Lord Lister pointed out in eloquently simple language the necessity for such laboratories in medical education, their importance both in teaching and research, and the benefits they were calculated to confer upon the College, upon Liverpool, and upon the neighbourhood. Lord Lister then, with a boldness and wisdom which compelled admiration, made a dignified statement as to the utility and humanity of experiments upon animals, which coming from such a man on such an occasion cannot but have a most beneficial effect. He concluded this part of his address with the sentence, "While I deeply respect the humane feelings of those who object to this class of inquiry, I assure them that, if they knew the truth, they would commend and not condemn them."

After the function in St. George's Hall, the company proceeded to University College, where the brief ceremony of declaring the laboratories open was performed by Lord Lister, after the presentation of a key in a silver casket had been made by the Chairman of the College Council. A similar key was retained for presentation to Mr. Thompson-Yates. Lord Lister and the large assembly of invited guests were then conducted in parties through the laboratories ; other parts of the College were also visited. Tea and refreshments were served in the Victoria building ; and, finally, the Lord Mayor's banquet at the Town Hall in the evening brought to a conclusion the formal proceedings of what stands out as the first great University function in Liverpool.

College functions have been frequent ; noble buildings and new laboratories belonging to University College have been opened before ; but now for the first time the professors and students appeared not merely as members of the College, but of the Victoria University. Liverpool is to be congratulated not only upon the splendid new laboratories, not only upon the impressive ceremonial of their inauguration, but also upon the fact that the first honorary degree conferred by her University, in the City, has been bestowed upon such a man as Lord Lister.

THE OPENING ADDRESSES AT THE MEDICAL SCHOOLS.

IN respect of an opening address there seems at the medical schools no fixed rule ; in some cases the first year's student plunges *in medias res*, and the first word he receives from his teachers is actually work ; in others a more or less philosophical discourse, often, it must be admitted, more suited to the practitioner or advanced student, forms the prelude to a medical curriculum. The actual need for an opening address on medical education is really somewhat less than would be thought, since the "Student's Numbers" of the *Lancet* or *British Medical Journal* contain usually all that can possibly be said in the way of general advice to the student, and these every student or his parents read. This fact, doubtless well known to those giving the addresses, is perhaps one explanation of the varied subject-matter which October after October gets worked up and delivered as introductory addresses. What is in a name? Whether the introductory address benefits the first year's student or not, it at any rate forms an excuse for a batch of interesting dissertations, which have at this season of the year, when returning from holiday and bent on work, an effect both stimulating and refreshing. Stimulating, because from these addresses we get glimpses of the varied character and enormous extent of the undiscovered country, which lies open to the scientific explorer; refreshing, because we get a few tastes, as it were, of the fruit of the promised land.

The address of addresses this year was Prof. Virchow's, which was printed fully in these columns last week. The Mason College, Birmingham, was fortunate in having Prof. Michael Foster as lecturer. The subject chosen was the nature and function of a university. Prof. Foster has a high ideal of what a university ought to be, and, in view of the formation of a Midland University, indicated at Birmingham, what should be the aims of those entrusted with the foundation of this University. It is a relief to-day, when universities are rather apt to be regarded as examination-framing and degree-giving machines, to hear an eloquent voice raised which emphasises the value to the medical student of research and individual laboratory supervision, as being not only the best but in the long run the quickest way of teaching him the way to think, and thus attack the problems which the future practice of his profession will present to him.

Mr. Turner, in his inaugural address at St. George's Hospital, directed the attention of his audience to, perhaps, a less ideal, but nevertheless an important subject. Mr. Turner contends, as many have done before, that the profession of medicine is not rewarded proportionally to its merits. Distinctions are *cæteris paribus* conferred less readily on medical men than on members of the legal or clerical profession. Further, authors have done a wrong to the medical profession on many occasions by distorting in fiction and elsewhere its characteristics. This, no doubt, is very true; but one is thankful that it is fast disappearing. That those in authority are not, or rather were not entirely to blame for these grievances is also equally true. The emergence of medical practice from crude empiricism to its present-day condition, demanding on the part of the medical unit higher intellectual faculties, as opposed to mere memory, which bring in their train an increased appreciation of the æsthetic, will certainly remedy the social position of the rank and file of the profession. The effect of this is already seen in the increasing numbers of medical *litterateurs* of the type of Oliver Wendell Holmes, and medical authors. Mr. Turner rightly not only indicated the disease, but suggested a remedy. While deprecating any attempt at organisation allied to trade unionism, he exhorted his hearers "to make by force their merit known," and cultivate amongst themselves an *esprit de corps* which would essentially overcome whatever obstacles it encountered.

A practical medical subject was the text of Dr. Caley's address at St. Mary's Hospital—prevention in medicine. Dr. Caley contended that to whatever extent the science of hygiene might develop, the actual prevention of disease will also depend upon the rank and file of the medical profession and the public. Some interesting points were brought out in this address with regard to some of Dr. Sidney Martin's researches on the effect of organically polluted soil on the retention of vitality by the typhoid bacillus. In the case of virgin soil inoculated with the bacillus, no signs of vitality were found after fourteen, twenty, or twenty-three days; in the case of polluted soil, the bacillus was thriving at the end of seven months. Dr. Caley emphasised the importance to Great Britain as a colonising power of the prevention of malarial fevers, and noted with satisfaction that, thanks to the new army medical regulations, a better class of army medical officer will be forthcoming. The lecturer further considered the application of prevention to tuberculous disease, and in this connection referred to the results of the Royal Commission on Tuberculosis and the recent French Tuberculosis Congress.

An important point in Dr. Voelcker's address at the Middlesex was the caution which he gave to students as to how they spoke of medical matters in lay circles. This might have been extended, as there can be no doubt of the incalculable harm that may be done by a student or doctor who is not possessed of tact. The public as a rule lose no time or spares no pains in making the most of what has the material in it of a medical scandal. Incautious students have before now doubtless unwittingly been sources of great mischief.

At the Royal Free Hospital, Dr. Walter Carr discoursed upon "Fashion in Medicine." Bleeding naturally found a place amongst the historic medical fashions, as also did the administration of calomel. Two present fashions in medicine were, according to Dr. Carr, the anti-toxine treatment and the treatment by animal extracts. At the close of the address he touched, appropriately to his audience, upon the future of the medical woman. He rightly urged the necessity of keeping up the standard of the medical woman, and gave a note of warning with regard to the possibility of the success, which had finally attended the movement, producing a less valuable individual.

The Pharmaceutical Society of Great Britain had the fortune to be addressed by Sir James Crichton Browne. Sir James pointed out that the examination of chemists and druggists ought to proceed on different lines to that of medical students in that the former were, as a rule, earning their livelihood by more or less manual service all the time they were in *statu pupillari*. Sir James discussed the sale of poisons and the possibility of new legislation upon this subject in the immediate future. The average poisoner, according to the lecturer, takes but little advantage of the recent discoveries of science. In this connection he pointed out the popularity of arsenic, which was used by Wonderton in his attempt, in 1384, to poison Charles VI. of France and the Dukes of Valois, Berri, Burgundy, and Bourbon. This drug was also the basis of the "manna" of St. Nicholas of Bari, and Toffania of Naples, which caused the deaths of 600 persons. In Sir James' experience no medical poisoner has ever used a drug outside Schedule A of the Poisons Act. From this circumstance the lecturer drew an interesting inference—viz. that medical poisoners, so far from being intellectual villains, were as a rule dull and stupid to a degree, since much more deadly and much less easily detectable substances lay to their hand, if only they would take the trouble to find them and be original. They are, in fact, another instance of intellectual incapacity being associated with moral debasement. The lecturer then entered upon the subject of disease toxines and allied bodies, and pointed out how in all probability the poisoner of the future would avail himself of this class of poison. In conclusion, the effect of anti-toxines in the prevention of the sequelæ of the infective diseases was pointed out; and basing his observations upon the dictum of Sir William Gull, that a patient took ten years to recover from an attack of typhoid fever, Sir James emphasised the benefit which would accrue to mankind from the use of these remedies.

Dr. Robert Saunby delivered an opening address at the Medical School of University College, Cardiff, on modern universities. The lecturer deplored the condition of university education in England so far as concerns medicine, and pointed to what was done by the State in Germany and France. This theme has been often dwelt upon, and not without effect. England is now waking up to the value of technical education, of creating places where men can pursue those studies which are to form their stock-in-trade for life.

The address at the Yorkshire College, Leeds, was given by Dr. Cullingworth upon the importance of personal character in the profession of medicine. The author referred to an interesting article by Sir James Paget on the result of an inquiry of what became of 1000 of his pupils fifteen years after their entry at St. Bartholomew's. This showed that 9 per cent. died within twelve years of their commencing practice, and forty-one, or about 4·5 per cent., during their pupilage, fifty-six failed entirely, the remainder were successful in all degrees varying from distinguished success to very limited success. This, on the whole, is not a bad average, and if it was possible to the medical student of 1870, more is possible and probable to the medical student of to-day.

From the above brief extracts it will be seen with what varied advice and dissertations the recruits of the medical profession have been introduced to their life study. The practitioner and advanced student, rendered more cynical, perhaps, by contact with his fellows, will be inclined, and possibly not altogether wrongly, to recall the words of Mephistopheles to the would-be medical student in *Faust*, and abide by them :—

The trade of medicine's easiest of all.
'Tis but to study all things—everywhere
Nature and man—the great world and the small.
Then leave them at haphazard still to fare.

F. W. TUNNICLIFFE.

SURGEON-MAJOR J. E. T. AITCHISON, M.D., C.I.E., F.R.S.

BOTANY has lost another of its devotees. Dr. Aitchison died at Kew on the 30th ult., at the age of sixty-three, after two or three years of bad health, consequent on a weak heart and other complications. He was a man of fine physique, and of a genial and happy disposition. The son of Major J. Aitchison, H.E.I.C.S., he was born in India in 1835. After successfully studying medicine and surgery at Edinburgh, he entered the Bengal medical service in 1858, and remained in it for thirty years. But it was as a botanical explorer and an investigator of the vegetable products of the various countries he visited that he was known in the scientific world. Enthusiastic, enterprising, and persevering in no ordinary degree, he succeeded in forming valuable botanical collections under difficulties that would have discouraged and prevented many men. Science is primarily indebted to him for collecting plants and their products and local information concerning them. In these investigations he was indefatigable ; and he had a rich field for his labours in North-west India, Afghanistan, Baluchistan, Persia, and Russian Turkestan. He seems to have been led to botanical pursuits by the study of Indian drugs, as in tracing their origin he became familiar with vegetable organography, and acquired a love for plants which he retained to the last. Indeed, he settled at Kew in order to be able to continue his studies. His first contribution (1863) to botanical literature was an enumeration of the plants of the Jhelum district of the Punjab, with notes on their products and distribution. It was in this paper that he published the only new species, I believe, that he ever described independently. For the many novelties he subsequently discovered he always called in professional aid, being too modest and too anxious for accuracy to attempt it alone.

Subsequently, in 1869, he published a catalogue of the plants of the Punjab and Sindh, which, however, was a good deal more than a catalogue. This was followed by a lengthy paper on the flora and vegetable products of Lahul, a "Handbook" on the trade products of Leh, and a number of smaller contributions to botanical literature. But his great harvest was made in Afghanistan and the surrounding countries. In the winter of 1878, he accompanied the troops under General (now Sir Frederick) Roberts into the Kuram Valley, and the following year was appointed botanist to the expedition. A collection of some 15,000 specimens of dried plants was made between Thal and Peiwarkotal, at elevations of 2500 to 15,000 feet. A further collection was made in 1880 in the same country ; and in 1884 he was appointed naturalist to the Afghan Delimitation Commission. This was even more fruitful than the previous expeditions, yielding about 800 species, represented by 10,000 specimens. But Dr. Aitchison not only collected specimens ; he also collected a large amount of local information concerning them. These immense collections were worked out at Kew, and the results published in the *Journal* and *Transactions* of the Linnean Society. The papers are prefaced by admirable descriptions of the vegetation and local conditions of the districts traversed. Apart from the plants collected by William Griffith during the first Afghan war (1839-40), Kew possessed very little from this interesting region ; hence Aitchison greatly enriched the herbarium and museum. In addition to the papers mentioned, he wrote a number of articles on the medicinal and other vegetable products of commercial value. I had almost forgotten to mention that he also collected zoological specimens.

Personally Dr. Aitchison was of a most amiable and kind-hearted disposition, and this, combined with his fine presence, tact and medical knowledge, enabled him to mix with the natives with impunity, and obtain information that others could not. One of the first things he did on arriving at a place was to treat the sick, and his reputation preceded him, so that he was often approached and besought for aid. In 1883 he was created a Companion of the Order of the Indian Empire, and in the same year he was elected a Fellow of the Royal Society of London. Unfortunately the last year of his life was saddened by the loss of his wife, to whom he had been deeply attached.

He was occupied during the last two years in preparing a *Flora Indiæ Desertæ*, to include the plants of North-western India, Baluchistan, and Afghanistan, but his ailments prevented him from doing more than collect materials. It is not possible to find at once an equally qualified person to carry this idea into effect.

Though Aitchison was little in society during the last four or five years, there are many who will feel the loss of one who was such a cheerful companion and warm friend. W. BOTTING HEMSLEY.

CONFERENCE ON THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

AT the Royal Society on Monday evening, the President and Council held a reception to meet the delegates attending the international conference upon an international catalogue of scientific literature. The conference began on Monday, and practically all countries actively engaged in scientific work are represented. The following is a list of delegates appointed to attend the conference :—

Austria.—Prof. L. Boltzmann (Kaiserliche Akademie der Wissenschaften, Vienna) ; Prof. E. Weiss (Kaiserliche Akademie der Wissenschaften, Vienna).

Belgium.—Chevalier Descamps (President de l'Institut International de Bibliographie, Brussels) ; M. Paul Otlet (Secretaire-General de l'Institut International de Bibliographie, Brussels) ; M. H. Lafontaine (Directeur de l'Institut International de Bibliographie, Brussels).

France.—Prof. G. Darboux (Membre de l'Institut de France) ; Dr. J. Deniker (Bibliothécaire du Museum d'Histoire Naturelle) ; M. E. Mascart (Membre de l'Institut de France).

Germany.—Prof. Dr. Klein, Geheimer Regierungs-Rath (University of Göttingen).

Hungary.—Dr. August Heller (Librarian, Ungarische Akademie, Buda-Pesth) ; Dr. Theodore Duka (in London).

Japan.—Prof. Einosuke Yamaguchi (Imperial University of Kioto).

Mexico.—Señor Don Francisco del Paso y Troncoso.

Netherlands.—Prof. D. J. Korteweg (Universiteit, Amsterdam).

Norway.—Dr. Jörgen Brunchorst (Secretary, Bergenske Museum).

Sweden.—Dr. E. W. Dahlgren (Librarian, Kongl. Svenska Vetenskaps Akademie, Stockholm).

Switzerland.—Dr. Jean Henri Graf (President, Commission de la Bibliotheque Nationale Suisse) ; Dr. Jean Bernoulli (Librarian, Commission de la Bibliotheque Nationale Suisse).

United Kingdom.—Representing the Government : The Right Hon. Sir John E. Gorst, Q.C., M.P., F.R.S. (Vice-President of the Committee of Council on Education). Representing the Royal Society of London : Prof. Michael Foster, Sec.R.S. ; Prof. Arthur W. Rücker, Sec.R.S. ; Prof. H. E. Armstrong, F.R.S. ; Sir J. Norman Lockyer, K.C.B., F.R.S. ; Dr. Ludwig Mond, F.R.S.

United States.—Dr. Cyrus Adler (Librarian, Smithsonian Institution, Washington).

Cape Colony.—Roland Trimen, Esq., F.R.S.

India.—Lieut.-General Sir R. Strachey, G.C.S.I., F.R.S. ; Dr. W. T. Blanford, F.R.S.

Natal.—Sir Walter Peace, K.C.M.G. (Agent-General for Natal).

New Zealand.—The Hon. W. P. Reeves (Agent-General for New Zealand).

Queensland.—The Hon. Sir Horace Tozer, K.C.M.G. (Agent-General for Queensland).

On Tuesday evening the Royal Society gave a dinner to the delegates at the Hôtel Métropole. Lord Lister occupied the chair, and many Fellows of the Society were present, in addition to the foreign representatives of science. The *Times* gives the following report of the speeches at the dinner :—

Prof. Rücker, in proposing "Science in all Lands," said that science had become the most cosmopolitan of all the professions. In his own case he had this year taken part, more or less, in four international meetings ; and he did not think there was any body of men or any other profession in which such cordial arrangements were made for the recognition of merit, foreign or otherwise, as the Royal Society. They had a regular organisation for recognising merit outside the geographical boundaries of the nation to which men belonged. They recognised great scientific triumphs as being triumphs, not for one nation, but for the world. Names like those of Pasteur, Helmholtz, and Maxwell were recognised as names of which the whole world was proud. Science was gradually forming a permanent international conference of scientific men, all communicating with each other by writings, if not by speech, and they were drawn together not only by the bonds of intellectual sympathy but by scientific friendship.

Prof. Darboux, of the University of Paris, acknowledging the toast in French, said that the ideas to which Prof. Rücker had given expression would receive the unreserved adhesion of all those who cultivated science for its own sake. The most illustrious scientific men always retained some trace of their origin and of their race, as might be seen in the differences between the genius of a Descartes, a Newton, a Cuvier, a Darwin, or a Lagrange. German science was characterised by depth and power ; French science by greater clearness and better method ; while English science, though frequently beset with difficulties and dangers, had by a bold and timely policy rescued free inquiry from being overwhelmed. Whenever men of science met one another face to face, notwithstanding the differences that might separate them, they felt drawn to each other by the bonds of common interests. Every man of science recognised in another seeker after truth, wherever he might be met, a friend ; and, though he did not cease to uphold the love for his Fatherland, he was proud to participate, as the delegates were participating now, in a work of peace, concord, and civilisation.

Prof. Weiss, director of the Imperial Observatory, Vienna, in proposing "Success to the Conference," said he had spent a few years in England in early childhood, and had learnt to love the English people ; and in declining age he had occasion to admire the scientific men of England—their earnestness and the skilful perseverance with which they carried out their researches. He trusted that the conference would be a success, and that it would form the foundation of an international catalogue of scientific literature which would redound to the benefit of science and to the glory of England.

Sir John Gorst, in acknowledging the toast, said that the conference, as far as his experience had gone, seemed to be an admirable instrument for forwarding the scientific purpose for which it had assembled. In the first place, its wisdom was derived from every part of the world. Amid all this diversity of knowledge, surely it was reasonable to expect that some progress might be made in the work which the conference had in hand. According to the different way in which the question struck the peculiar idiosyncrasy of the different nationalities, they were much more likely to arrive at the truth than if left to blunder it out in their own British fashion without the assistance of minds very diverse from their own. He was not sure that the concert of Europe was in political affairs always a very brilliant success, but he thought that the concert of Europe in scientific affairs, free as it was from the drawbacks which accompanied political action—all the members of a conference of this kind being animated by only one desire, and that was the attainment of truth, having no personal and no national interest to serve outside the attainment of truth—a concert of that kind was one of the most valuable methods which the comity of modern nations had discovered for the propagation of all kinds of science and knowledge.

Prof. Korteweg proposed "The Royal Society."

Lord Lister, in acknowledging the toast, said it had been a great satisfaction to hear from delegates the very cordial feelings expressed towards the society. He confessed that he had sometimes entertained fears that the task undertaken by the conference was too gigantic to be satisfactorily completed, but he felt encouraged that evening when he heard that the work seemed to be going forward satisfactorily, and that there was a fair prospect that it would be completed in such a way as would tend to cement even more firmly than at present the union of international science.

Prof. Armstrong proposed "Our Guests."

Le Chevalier Descamps, delegate from the Belgian Government, expressed the gratitude which the delegates from foreign Governments felt at the kind reception accorded by the members of the Royal Society, and pointed out that their labours all tended in the direction of cementing still more closely the bonds of international scientific brotherhood. Their work in the conference, though being carried on modestly, was bound to be fruitful of good results, for bibliography had no pretensions to reform the world.

Prof. Klein proposed "The Secretaries," which was responded to by Prof. Michael Foster. Among the other speakers were Prof. Boltzmann, Sir Norman Lockyer, M. Mascart, Sir William Crookes, Dr. Graf, and Dr. Cyrus Adler.

NOTES.

WE understand that the vacancy in the Assistant-Directorship of Kew Gardens, caused by the appointment of Mr. D. Morris as Commissioner of Agriculture for the West Indies, will not be filled up. Mr. S. T. Dunn has been appointed Secretary to the Director.

THE *Botanisches Centralblatt* states that Prof. P. Knuth, of Kiel, is starting this month on a scientific expedition round the world, extending over from eight to ten months. He proposes a considerable stay in Buitenzorg, Java, visiting India on his way, and afterwards China and Japan, Honolulu and North America. Prof. K. Goebel, of Munich, is also starting, this autumn, on a botanical journey to Australia and New Zealand.

THE banquet of the Chemical Society to those of its past-Presidents who have completed fifty years' fellowship of the Society, which was postponed last June owing to the lamented death of the senior past-President, Lord Playfair, is now arranged to take place on Friday, November 11, at the Hôtel Métropole. The past-Presidents who will then be entertained are:—Sir J. H. Gilbert, F.R.S., Sir Edward Frankland, F.R.S., Prof. Odling, F.R.S., Sir F. A. Abel, Bart., F.R.S., Dr. A. W. Williamson, F.R.S., and Dr. J. H. Gladstone, F.R.S.

PROF. S. SCHWENDENER, of the University of Berlin, has been made a Knight of the Order *pour le mérite* in the class of science and art. We learn, from the *Botanical Gazette*, that the Order was founded by Frederick the Great, as a mark of distinction for military service; but the statute was revised in 1842 by Frederick William the Fourth, to include scientific men and artists of distinction. The latter class is limited to thirty Germans and thirty foreigners. The order is practically conferred by vote of the members. Prof. Schwendener is the only botanist who has been elected.

UPON the nomination of the Director of Kew Gardens, Mr. C. A. Barber has been appointed Government Botanist at Madras, in succession to the late Mr. M. A. Lawson.

THE Welby Prize of 50*l.*, offered for the best essay on "The causes of the present obscurity and confusion in psychological and philosophical terminology, and the directions in which we may hope for efficient practical remedy," has been awarded to Dr. Ferdinand Tönnies, of Hamburg.

AT the national observatory upon the Pic du Midi, a few days ago, two busts of General Champion de Nansouty and the engineer, M. Vaussenat, the founders of this useful meteorological establishment, were unveiled. M. Mascart, to whose suggestion the erection of the busts is due, and M. Baillaud, director of the Toulouse Observatory, delivered addresses to an audience of about five hundred persons who had assembled in the observatory.

THE handsome amphitheatre at the new Sorbonne has inscribed on the ceiling (says the *Chemist and Druggist*) the names of forty-five illustrious chemists. England is well represented by Cavendish, Priestley, Wollaston, Dalton, Davy, Faraday, Graham, and Griess—eight in all. The twenty-six French names are Lavoisier, Berthollet, Leblanc, Proust, Vauquelin, Thénard, Gay Lussac, Dulong, Chevreul, J. B. Dumas, Dessaignes, Balard, Boussingault, Pélouze, Laurent, Gerhardt, Regnault, Péligot, Cahours, Ebelmen, Fremy, Wurtz, Henri St. Clair Deville, Debray, and Pasteur. Sweden is represented by Scheele and Berzelius, Russia by Zinin and Butlerow, Belgium by Stas, Switzerland by De Marignac, and Germany by Mitscherlich, Wöhler, Liebig, Kolbe, and Kekulé.

SIR WILLIAM MACCORMAC, BART., and Sir Francis Laking have been appointed Knights Commander of the Royal Victorian Order, and Mr. A. D. Fripp and Fleet-Surgeon A. G. Delmege have been appointed Members of the Fourth Class of the same Order, in recognition of their services in connection with the recent accident met with by H.R.H. the Prince of Wales. The Royal Victorian Order is bestowed upon "such persons, being subjects of the British Crown, as may have rendered extraordinary, important, or personal service to Her Majesty, her heirs and successors, and who have merited Her Majesty's royal favour."

THE Harveian Oration will be delivered by Sir Dyce Duckworth on Tuesday next, at the Royal College of Physicians. The Bradshaw Lecture will be delivered by Dr. W. M. Ord on Thursday, November 10. The Goulstonian Lectures will be given next year by Dr. G. R. Murray, who has taken for his subject the Pathology of the Thyroid Gland. The Lumleian Lectures for next year will be given by Dr. Samuel Gee. The Croonian Lecturer for 1899 is Prof. Bradbury, and for 1900 Dr. F. W. Mott, F.R.S.

A MEETING of the Institution of Mechanical Engineers will be held on Wednesday and Thursday evenings, October 26 and 27, at the Institution of Civil Engineers, Great George Street, Westminster. The chair will be taken by the president, Mr. Samuel W. Johnson, at half-past seven p.m. on each evening. The following papers will be read and discussed, as far as time permits:—"Electric installations for lighting and power on the Midland Railway, with notes on power absorbed by shafting and belting," by W. E. Langdon; "Results of recent practical experience with express locomotive engines," by Mr. Walter M. Smith; "Mechanical testing of materials at the locomotive works of the Midland Railway, Derby," by Mr. W. Gadsby Peet.

A CIRCULAR informs us of a proposal to place in Corsock Parish Church, by half-guinea subscriptions, a suitable memorial to the memory of Prof. James Clerk Maxwell. There is already in the church a memorial to the memory of his father, John Clerk Maxwell, by whose influence and exertions the church was originally built. "This church," we read, "is chosen for the memorial, as the Professor's connection with it through life was very close. He was led to it as a child by his father; taught in its Sabbath School; was ordained an elder within its walls, and acted as such up to the time of his death; gave liberally towards its endowment, and the first and largest subscription towards the manse; was a trustee of the church and properties; and otherwise interested himself in its behalf." Subscriptions for the memorial may be sent to the Rev. George Sturrock, The Manse, Corsock, by Dalbeattie, N.B.

THE fifth International Congress of Hydrology, Climatology and Medical Geology, was held during last and part of the present week at Liège, Belgium, under the patronage of H.R.H. the Crown Prince of Belgium, and the Presidency of the Minister of Agriculture. The Congress was well attended by representatives of various nationalities. Many important communications were read and discussed in the various Sections, but the most interesting was an address given before the whole Congress by Prof. Walthere Spring, Professor of Chemistry at the University of Liège, on the colours of natural waters. Prof. Spring showed experimentally that the true colour of pure water is blue as in the Lake of Geneva, and that this colour is the colour proper to the water, and is not due to a mere reflection from the surface, nor from suspended particles in the water. When pure water has a very slight cloudiness, due to the presence of finely divided nearly white or colourless particles in suspension, even if these are absolutely colourless, as in the case of very finely divided rock crystal, a yellow tint is given to the water, which, together with the natural blue proper to the water itself produces a green colour, as in the cases of the Lakes of Neuchatel and of Constance. He remarked that it had been noted by various observers that the water of certain lakes usually green becomes occasionally absolutely colourless, and this he showed was due to the washing into the lakes of a fine mud of a reddish tint due to oxide of iron, which neutralises the green colour of the water, rendering it for the time being perfectly colourless. In connection with the Congress, interesting excursions were made to visit the bathing establishments, and to inspect the sanitary arrangements of Ostend and Middlekerke, Spa, Chandfontaine, and Aix-le-Bains. The Sanitary Institute was represented by Dr. Corfield, the Professor of Hygiene and Public Health at University College, London, who was elected an Honorary Vice-President of the Congress, and was also appointed the English Member of an International Committee which was formed for the purpose of inquiring into the means to be adopted for the preservation of the purity of the sources of natural mineral waters.

A COMPLIMENTARY dinner was given to Prof. Virchow at the Hôtel Métropole on Wednesday in last week. The chair was occupied by Lord Lister, and more than two hundred representatives of medical science and practice were present. Lord Lister, in proposing the toast of the evening, dwelt upon the versatility of the genius of the distinguished guest, his eminence as a pathologist being equalled by his reputation as an anthropologist and antiquarian. He referred particularly to Virchow's "Cellularpathologie," which work, he remarked, "swept away the false and barren theory of a structureless blastema, and established the true and fertile doctrine that every morbid structure consists of cells which have been derived from pre-existing cells as a progeny. Cellular pathology is now universally recognised as a truth. Even those morbid structures which deviate most from the normal structure are known to be derived as a progeny from normal tissue—from normal cells, driven to abnormal development by injurious agencies." In acknowledging the toast, Prof. Virchow made allusion to Huxley and his work in these words: "I have been touched by the confidence you have placed in me in choosing me to renew the remembrance of the great investigator whose commemoration we have just been celebrating. My task the other day demanded that I should demonstrate Huxley's influence upon the development of medical science. To-day I wish to emphasise that his merits in anthropological and ethnological respects are so great in the eyes of German investigators that they alone would suffice to procure immortal reverence for his name. We shall not cease to follow in his footsteps and to defend the place which he has assigned to man in nature. Together with you we will try to clear up in every direction the biological history of man. May this task still further confirm and strengthen the solid union of English and German science. May the corporations of Great Britain and Ireland, which form a bulwark of medical science and practice that has remained unshaken for centuries, continue to give the world by teaching and example a guarantee that the results of our science may benefit mankind in an ever increasing degree."

INOCULATION against plague has been accomplished on a very large scale at Hubli. The present population of Hubli is about 40,000, and a correspondent of the *Times of India* reports that up to September 7, 35,000 had been inoculated as a protection against plague, while about two-thirds of this number had been inoculated twice. Out of the whole proportion, therefore, there only remained about 5000 people who had not been inoculated at all; and by far the greater number of deaths which occurred were amongst these people. The returns for the first week in September show amongst 32,000 inoculated persons 69 attacks, and amongst 8500 uninoculated 417 attacks, which facts speak for themselves. The chief medical officer, Dr. Leumann, is writing a report on the results which he has obtained from inoculation, and this ought to prove most interesting not only to those who are connected with plague, but to all the races who live in India. It is to be hoped that the report will be widely distributed, in order that the practical proofs which have been obtained may become the means of giving confidence to the wavering, and to those who at present regard the system of inoculation with fear, and are disposed to treat it with resistance.

A TRIBUTE to the genius of Lord Kelvin is paid by Prof. Oliver Lodge in the form of an article in the *Liverpool Daily Post* (October 4). After describing some of the ingenious devices and instruments which have made Lord Kelvin's name known to the public, Prof. Lodge refers to his more purely scientific work in the following terms:—"The modern theory of electricity, developed so brilliantly by Clerk Maxwell, was begun by him. The science of thermodynamics owes much to him; the theoretical laws of thermoelectricity were wholly worked out by him; and to him long ago is due the theory of those electric oscillations which were elaborated practically by Hertz, and have recently been exciting some popular interest as affording a method of wireless telegraphy. In the higher regions of optics also he has worked much, and in his Baltimore Lectures and elsewhere has striven to unveil the mystery of the connection between ether and matter, as revealed in the facts of radiation, fluorescence, phosphorescence, selective absorption, and dispersion. The definition and the experimental determination of the absolute zero of temperature are both due to him. The vortex theory of matter constitutes one of his most brilliant but incompletely worked out speculations. The kinetic theory of its elasticity and rigidity is a definite contribution to that view of the physical universe which seeks to resolve the whole of merely material existence into the two fundamental entities—ether and motion. Let any one ask what is the size of an atom, and he is referred to Lord Kelvin. Let him ask what is the age of the earth, and if he mean anything definite by this question—if he mean, for instance, what time has elapsed since the earth was a molten mass beginning to cool, it is again to Lord Kelvin that he must go. And then the tides; all the higher mathematical work on the tides, with their various causes and perturbations, is based on Kelvin's pioneering work, and to him all writers on this abstruse subject look up and defer as their master." The words in which Prof. Lodge concludes his article glow with appreciation. They are:—"Happy in the circumstances of his education, pertinacious in his unwearying industry, and undistracted by other interests from a constant devotion to definite dynamical science, narrow perhaps in some of its aspects, but all the more intense for that, he stands before us now a monument of human power and influence, one of the benefactors of the human species, one who has been happily preserved with hardly diminished energy for nearly sixty years of peaceful epoch-making work, one on whom posterity will heap high honours, and will regard with feelings of envy us of the present generation who are still illuminated by his living presence."

ON account of its practical importance, the influence of the chemical composition of a glass upon its coefficient of expansion has attracted the attention of several workers, more especially Fizeau, Schott, Châtenet, and Grenet. In the current number of the *Moniteur Scientifique* is an interesting *résumé*, by M. A. Granger, of the results obtained up to the present in this very complicated field. The simple rule tentatively proposed by Schott, that the expansion follows an additive law, is only approximately followed in a few cases, as quite a considerable number of substances, such as the oxides of lead, calcium, manganese, aluminium, and boron, possess the property of lowering the dilatation when added in small quantities, and raising it when the proportion is increased. The addition of either potash, soda, lithia, fluorspar, lime, or calcium phosphate raises the coefficient of expansion of a glass, but with the exception of the last, which may be added up to 20 per cent., not more than 8 per cent. can be used. For proportions higher than this, the glass either refuses to take up any more, or else becomes devitrified and opaque. Calcium borate, oxide of iron, alumina, and silica have the effect of lowering the coefficient of expansion, alumina being especially active in this respect.

THE following neat result in the dynamics of impact is proved by Ingegnere D. De Francesco in the *Rendiconto* of the Naples Academy for July :—In the impact of two perfectly smooth solid bodies, the kinetic energy due to the velocities lost is a minimum compatibly with the final value of the difference of normal velocity of the points of contact. It is to be observed that the function which De Francesco proves to be a minimum is not the actual kinetic energy lost by impact, but a quadratic function of the differences of velocities before and after impact of the same form as the kinetic energy. The theorem is somewhat analogous to several of the "minimum" theorems given in the chapter on "Vis Viva" in Dr. Routh's familiar "Elementary Rigid Dynamics," and, to use a common way of speaking among mathematicians, the result "comes out in about a line."

WE have received from Major-General Schaw a copy of papers read before the Wellington Philosophical Society, on Australasian weather charts and New Zealand storms. Charts were exhibited illustrating types of summer and winter storms, and showing their progress eastward from the Great Australian Bight to New Zealand. The author urges that the phenomena exhibited in these charts of horizontal motion and atmospheric pressure, need for their elucidation a knowledge of the vertical circulation. With this object he has constructed a wind vane showing the wind direction both vertically and horizontally, and has made careful observations during several months. The observations showed that at times the upward or downward inclination prevails for hours, while at other times there may be for hours no regular deviation from the horizontal. The author refers to similar experiments by Prof. A. Klossovski at Odessa, which have been noticed in our columns, but makes no mention of those made by the Rev. M. Dechevrens at Zi-ka-wei Observatory.

THE Report of the Meteorological Commission of the Cape of Good Hope for the year 1897 has been published. Barometric and thermometric observations are recorded from forty-six stations, and observations of rainfall from 336 stations. As an encouragement to continuous observations, the Commission presents to observers the instruments with which they have made a series of satisfactory observations for a period of not less than five years. Among the contents of the Report, in addition to the meteorological statistics and summaries, are useful notes for the guidance of observers, prepared by Mr. C. M. Stewart, Secretary of the Commission, and a short paper by Mr. A. Struben, upon the rainfall maps of South Africa, prepared by Dr. A. Buchan. The Report is illustrated by a map showing the distribution of summer and winter rainfall in percentages of the mean annual fall over the whole of South Africa, and by diagrams showing the mean monthly rainfall in each division, and the departures from the means of 1885–94. Another report of meteorological observations lately received contains the results of observations made during 1897 in the four Government observatories at Bangalore, Mysore, Hassan, and Chitaldrug, under the direction of Mr. J. Cook. A comparison is made between the results for 1897 and the means of the weather elements at these places during the last five years.

A NOVEL plan has recently been carried out at the Avonmouth Dock, at Bristol, for increasing the capacity of the lock so as to adapt it for the use of the larger vessels which have for the last few years been coming into use. The length between the gates of the lock, as originally constructed, is sufficient to dock a vessel 425 feet in length; but the vessels now trading between Bristol and Canada are 465 feet long, and could therefore only enter and leave the dock at spring tides. To provide for their entering at all tides, the useful length of the dock has been increased by the adoption of a floating steel caisson which fits into grooves cut in the masonry of the lock walls beyond the outer gates, and which serves the same purpose as the gates, only giving an increased length to the space available for locking of 40 feet. This caisson is 70 feet long, 30 feet wide, and 46 feet high. When the vessel has entered the lock, the caisson is floated from its berth and placed in the grooves; the tanks are then filled with water sufficiently to sink it on to its sill. When the locking is completed, the water is pumped out, and the caisson floated back to its berth. The steamer *Montrose*, which arrived from Canada a few days since with a large cargo of provisions, on a neap tide, and which is 465 feet in length, was the first vessel to be docked by the aid of the caisson.

THE Report of Dr. D. Prain, the Director of the Botanical Survey of India, for the year 1897–98, is largely occupied by a continuation of Prof. Woodrow's Flora of Western India. He records the botanical explorations which have been made during the year of portions of Assam and Burma; in the latter of which great assistance was rendered by Lieut. E. Pottinger, R.A.

A NEW edition of Mr. C. J. Woodward's "Arithmetical Chemistry," Part i., has been published by Messrs. Simpkin, Marshall, Hamilton, Kent, and Co., Ltd. The book has been rewritten, with additions in the form of hints and suggestions for experimental work as a basis for the lessons. Elementary students of chemistry are thus instructed in laboratory methods, as well as given numerous arithmetical problems which will help to make them understand the value of quantitative work.

VOL. I. No. 2 of the *Records of the Botanical Survey of India* is entitled a "Note on the Botany of the Kachin Hills north-east of Myitkyina." It is, however, more than a "note," consisting of a record of the results of Lieut. E. Pottinger's journey through this district of Burma. After some preliminary general notes on the Botany of the Kachin Hills by Lieut. Pottinger and Dr. D. Prain, a complete list is given of the Flowering Plants and Vascular Cryptogams collected, the district proving especially rich in Orchideæ. A small map is appended.

MR. STANFORD has now concluded the arrangements for the completion of the re-issue of his "Compendium of Geography and Travel." The Europe volumes are in the hands of Mr. George G. Chisholm, who has finished Volume i., comprising the countries of the mainland (excluding the north-west), and has Volume ii., covering the British Isles, Scandinavia, Denmark, and the Low Countries, in hand. The volumes on Central and South America have been entrusted to Sir Clements Markham and Mr. A. H. Keane, and they will be furnished with the usual maps and illustrations. Mr. Stanford hopes to complete the issue of the series in the course of 1899.

FROM the United States we have the following botanical publications of taxonomic interest :—Revision of the Mexican and Central American species of *Galium* and *Relbunium*; and Diagnoses of New and Critical Mexican Phanerogams, by J. M. Greenman (Contributions from the Gray Herbarium of Harvard University); also Onagraceæ of Kansas, by Prof. A. S. Hitchcock, with sketch-maps of the distribution of each species (in French and English, published at Le Mans). And from Australia:—Contributions to the Flora of New Guinea; Contributions to the Flora of Queensland (Fungi); and Edible Fruits indigenous to Queensland; all by F. M. Bailey.

AN elaborate illustrated catalogue of chemical and physical apparatus has been issued by Messrs. Reynolds and Branson, Ltd., Leeds. No less than three thousand separate pieces of apparatus are numbered in the catalogue, and very many of them are illustrated. The large number of physical appliances and instruments included in the catalogue is an indication of the important part which instruction in physics now takes in science schools. Teachers of practical science, more especially those working in connection with the Department of Science and Art, will find the catalogue serviceable when considering the purchase of apparatus.

M. C. SCHUYTEN publishes in the *Bulletin* of the Belgian Academy a continuation of his researches on the double salicylates of certain metals and antipyrin. He now finds that the salicylates of magnesium, of manganese and of lead, as well as certain others previously investigated, give rise to compounds with antipyrin, while he has found it impossible to realise, under the same conditions, the formation of double salicylates of aluminium, of chromium, and of uranium and antipyrin. The case of bismuth is reserved for future consideration. M. Schuyten calls attention to the instability of these compounds in which water easily promotes dissociation.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, presented by Mrs. Henry Lloyd; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mrs. Snowden; an Indian Wild Dog (*Cyon aukhunensis*, ♂) from India, presented by Surgeon-Lieut.-Colonel J. Duke; an Egyptian Jerboa (*Dipus ægyptius*) from North Africa, presented by Mr. David Devant; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Molteno; a Golden Eagle (*Aquila chrysætus*), British, presented by the Rev. F. Foxhambert; a Black-headed Caique (*Caica melanocephala*) from Demerara, presented by Master Bertie Standing; a Common Squirrel (*Sciurus vulgaris*) from Austria, presented by Mr. A. M. Wigram; a Puma (*Felis concolor*) from America, a Reticulated Python (*Python reticulatus*) from the East Indies, deposited.

OUR ASTRONOMICAL COLUMN.

VARIABLE STARS IN CLUSTERS.—American astronomers have, during the last few years, made great advance in increasing our knowledge relating to variable stars. Nor have they limited themselves to photographic surveys of variable stars of the ordinary type, but have been examining clusters of stars to detect variability. Prof. Bailey, who has been very successful in this direction, has just undertaken a systematic search which has led him to some most interesting results (*Harvard College Observatory Circular*, No. 33). This *Circular* informs us that the whole number of stars examined in the photographs was 19,050, of which 500 were found to be variable, thus representing a variability of about 3 per cent. This at first does not seem a very high percentage, but, as Prof. Pickering points out, "it does not follow, however, that clusters in general contain more variable stars than occur elsewhere, for, if we except the four clusters ω Centauri, Messier 3, Messier 5, and Messier 15, which contain 393 variables, an average of 7 per cent., the remaining 19 clusters have 116 variables among 13,350 stars, or less than 1 per cent." Even clusters which are equally rich in stars show great differences in this respect: thus the great cluster in Hercules (Messier 13) has only two variables out of 1000 stars, while in Messier 3, of 900 stars, 132 are variable. Not only have variables in these clusters been detected, but their periods and light curves are being carefully determined. In the case of the cluster ω Centauri, which up to the present has received most attention, 150 photographs have been taken with the 13-inch, and already 10,000 measures have been made. Of the 3000 stars used in this cluster for comparison, 125 have been recorded as variable. The periods of 106 have been determined, and 98 of these have periods less than 24 hours, the largest range in variation being about 5 magnitudes; no star is included which varies less than half a magnitude. Prof. Pickering has divided these 98 variables into four classes, namely, those which have a very rapid rise to maximum, those like η Aquilæ with a secondary maximum, those whose times of increase and decrease are about equal, and lastly those which drop very suddenly from maximum to minimum: attention is called also to the marked regularity in the periods. In referring to the kind of clusters in which variables have been detected, he says that up to the present time only such dense globular clusters as Messier 3, Messier 5, and the great cluster in Hercules have been found to contain them.

LARGE METEORS IN 1897 AND 1898.—Mr. W. F. Denning in the *Observatory* for the present month brings together a number of notes concerning fireballs and bright meteors which have been observed in England during the last year and a half. In many cases sufficient and accurate information was available to enable their real paths to be determined. The radiant-points which have been derived from these observations are in most cases, as he says, very interesting, as they suggest evidence of new showers or corroboration of others previously observed.

As we have on several occasions in this column pointed out the great necessity of obtaining accurate and complete information of the path of these roving bodies through our atmosphere, so that observations may be comparable with one another, it is encouraging to read, and Mr. Denning himself is the writer, that "it is clear . . . that this department is receiving more attention than formerly. It is hoped that this interest will continue to increase, and that the fortunate spectators of fireballs will never forget to record those all-important features, viz. the direction and position of the flight amongst the stars and the duration of visibility."

REMINISCENCES OF AN ASTRONOMER.—Prof. Simon Newcomb continues in *The Atlantic Monthly* for September his reminiscences, from which we make the following few extracts. In one of his journeys to observe a total eclipse of the sun he went to Gibraltar, and one of the first things he did the morning after his arrival was to choose "a convenient point on one of the stone parapets for 'taking the sun,' in order to test the running of my chronometer. I had some suspicion as to the result, but was willing to be amused. A sentinel speedily informed me that no sights were allowed to be taken on the fortification. I told him I was taking sights on the sun, not on the fortification. But he was inexorable; the rule was that no sights of any sort could be taken without a permit." Needless to say Prof. Newcomb soon obtained the required permit, and was allowed to continue his sights without interruption.

Having some important work to do with regard to the motion of the moon, and the Franco-Prussian war being on at the time, Prof. Newcomb went to Berlin, *viâ* Naples to pass the winter, and to wait till the war was over, until he could visit Paris. Having arranged his luggage so that on landing at Naples the Custom House officer should find anything that was subject to duty at the top of his trunk, the officer contemptuously threw the top things aside, and devoted himself to a search at the bottom. "The only unusual object he stumbled upon was a spy-glass enclosed in a shield of morocco. Perhaps a gesture or a remark on my side aroused his suspicions. He opened the glass, tried to take it to pieces, inspected it inside and out, and was so disgusted with his failure to find anything contraband in it that he returned everything to the trunk, and let us off."

Speaking of Prof. Auwers, who "stands at the head of German astronomy," he says, "in him is seen the highest type of the scientific investigator of our time, one perhaps better developed in Germany than in any other country. The work of men of this type is marked by minute and careful research, untiring industry in the accumulation of facts, caution in propounding new theories or explanations, and, above all, the absence of effort to gain recognition by being the first to make a discovery." Journeying to Pulkova to visit Otto Struve, Prof. Newcomb relates many interesting reminiscences. After mentioning that the instruments which Struve designed sixty years ago still do the finest work of any in the world, he tells us that the air there "is remarkably clear; the entrance to St. Petersburg, ten or twelve miles north, is distinctly visible; and Struve told me that during the Crimean war he could see, through the great telescope, the men ou the decks of the British ships besieging Kronstradt, thirty miles away." Towards the latter part of these reminiscences, Prof. Newcomb mentions his meeting with Hansen, "who was at odds with him on a scientific question," the question being that Hansen was the author of a theory that the further side of the moon is composed of denser materials than the side turned towards us. We must, however, leave our readers here to study this article for themselves for further details, as we have already extended this note beyond the usual limit.

THE CAPE OBSERVATORY REPORT.—Dr. Gill's report to the Secretary of the Admiralty of the work done at the Cape Observatory during the year 1897, shows the great state of activity which has pervaded the whole atmosphere of the observatory during the past twelve months. It will be remembered that Mr. McClean last year made a stay at the Cape to complete his spectroscopic survey of all stars down to 3·5 magnitude, his 20-degree prism being fitted on to the 12-inch astrophotographic telescope. Unfortunately Mr. McClean's magnificent gift to the observatory did not arrive from Dublin during his stay, as was expected, so that he was deprived of the pleasure of witnessing its erection. The observatory for this instrument is completed as far as possible, and is only now waiting for the arrival of the heavy portions of the telescope. The rising floor and its hydraulic machinery have been set up, and, as Dr. Gill says, "the whole has been admirably designed by Mr. McClean and Mr. Osbert Chadwick, . . . it was erected here under my personal supervision by Cape workmen, and acts to perfection." The plans for the new transit circle and observatory have been settled in complete detail, and both will be executed with as little delay as possible. The transit circle has been employed chiefly for observations of standard stars required for the reduction of measures of the Catalogue photographic plates. A system of double watches with this instrument was organised so that the observers would be ready to take up the fundamental meridian work with the new transit circle in 1900. Both the equatorials have been employed, and the 7-inch was chiefly used by Mr. Innes for observing the stars in four lists forwarded by Prof. J. C. Kapteyn. In this work a star of the eighth magnitude was discovered "having an annual proper motion amounting to nearly 9″ of arc on the great circle, *the largest proper motion yet known*." Besides several uncatalogued nebulæ, Mr. Innes has found no less than 128 new double stars. Many of our readers may not be aware that Mr. Innes is secretary, librarian, and accountant to the establishment, but "has applied himself to the revision of the Durchmusterung and other extra-meridian work (which he has performed as a labour of love), in addition to the thorough discharge of his official clerical duties." To refer to the work accomplished and proposed for the heliometer, the observations of the zenith telescope, the state of current reductions, publications, time service, would make this note too long, so we will only confine ourselves, in conclusion, to the fact that proposals have been sent forward for erecting a suitable building for a physical laboratory and accommodation for records and astrographic work.

ZOOLOGY AT THE BRITISH ASSOCIATION.

ALTHOUGH the foreign zoologists who had attended the International Congress at Cambridge a week before did not stay on for the British Association meeting, as had been expected, still the attendance at Section D was good, and many of the papers were of an interesting character. The number of papers was not large, so the Section did not meet on Saturday and Wednesday.

Prof. Weldon's presidential address gave a useful popular discussion of some of the principal objections which are urged against the theory of Natural Selection, and showed (1) that the law of chance enables one to express easily the frequency of variations among animals; (2) that the action of Natural Selection upon such fortuitous variations can be experimentally measured; and (3) that the process of evolution is sometimes so rapid that it can be observed in the space of a few years.

The Section did not sit in the afternoon, but a Biological Exhibition at the Clifton Zoological Gardens was opened at three o'clock by Sir John Lubbock.

Friday, September 9.—The following papers were taken:—Prof. E. B. Poulton, on the proof obtained by Marshall that *Precis octavia-natalensis* and *P. sesamus* are seasonal forms of the same species. The specimens were exhibited.

Mr. F. Galton, on photographic records of pedigree stock. This was for the purpose of urging the systematic collection of photographs and information as to pedigree stock. Galton's ancestral law proves the importance of a much more comprehensive system of records than now exists. A breeder ought to be in a position to compare the records of all the near ancestry of the animals he proposes to mate together in respect to the qualities in which he is interested. More especially he ought to have access to photographs, which indicate form and general attitude far more vividly than verbal descriptions. Mr. Galton considers that every important stallion or bull should have a pamphlet all to himself, with photographs of his ancestry and with appropriate particulars about each of them. Mr. Galton, finally, proposes a scheme for the consideration of societies which publish stud books.

Mr. W. Garstang, on the races and migrations of the mackerel. From the examination of a large number of mackerel Mr. Garstang is able to distinguish the following three races:—(1) American, (2) Irish or Atlantic, and (3) North Sea and Channel. Each of these races, he considers, does not wander far from its own coast in winter, and does not mix with the other races, but merely moves out into deeper water. Mr. Garstang also gave, along with Mr. H. N. Dickson, an account of the connection between the appearance of mackerel and the changes of sea temperature in spring and autumn. Whether the movements of the mackerel are determined directly by the temperature or indirectly through food was left unsettled; but the authors proposed a more detailed biological and physical investigation of the English Channel.

Prof. A. B. Macallum gave a short paper calling attention to points in the microchemistry of cells. A report was presented by the Committee on Zoological Bibliography and Publication, and also one by the Index Animalium Committee, giving an account of Mr. Sherborn's work at the Natural History Museum. The Canadian Biological Station Committee, appointed last year at Toronto, reported in favour of a floating station to be established in the Gulf of St. Lawrence for five years. Their application to the Dominion Government for an appropriation for construction and maintenance has been granted.

The report from the Plymouth Marine Biological Laboratory contained an account by Mr. G. Brebner of his algological work, by Mr. F. W. Gamble on his investigation of the nerves of Arenicola, Nereis, and other Polychæts by the methylene blue method; and by Prof. Hickson on the embryos of Alcyonium collected by Mr. Wadsworth.

The Committee on the Zoology of the Sandwich Islands stated that work was in progress, and that they hope to be able soon, with the aid of the Royal Society and the Bishop Museum in Honolulu, to publish a volume of investigations.

Dr. Arthur Willey's paper "On the phylogeny of the Arthropod amnion" stated that the importance of the problem lies in the fact that the principle which will account for the amnion of insect embryos is the same as that which has been applied by Prof. Hubrecht to the mammalian amnion. The insect amnion is not cenogenetic and is not due to mechanical causes, as is the prevailing impression, but it is of palingenetic significance. The material which supplied the necessary data for coping with this problem consisted of the embryos of a species of *Peripatus* (*P. novæ britanniæ*) which Dr. Willey found in New Britain last year. These embryos possess a remarkable trophic organ, the epidermal layer of which is called the trophoblast, and the latter is the forerunner of the serosa of insect embryos—the serosa being the essential structure in connection with the embryonic membranes of insects, the amnion being accessory or incidental to the serosa.

The report from the Naples Zoological Station, in addition to the usual statistical information as to the progress of the station, contained accounts by the three naturalists who have occupied the British Association table during the year as to their special work. Mr. J. F. Gemmill investigated the pseudobranch and the intestinal canal of Teleosteans. Mr. H. M. Vernon writes on the relations between marine animal and vegetable life in aquaria; and on the relations between the hybrid and parent forms of echinoid larvæ. Mr. J. Parkinson worked at the variation of species of *Cardium*, *Donax*, and *Tellina*. The object of Mr. Vernon's interesting work was to determine how the nitrogenous matter excreted by marine animals into the water is removed, and what parts the various forms of vegetable life and other agencies play in the process. Bacteria are of importance. It was found that the pipes conducting the water from the reservoirs to the rooms were coated internally with a layer of bacterial slime, and that in its passage along these pipes the water underwent considerable purification. Probably in marine aquaria a more powerful purifying influence than the bacterial is exerted by the diatoms and minute algæ.

An interim report was presented by the Committee on Bird Migration in Great Britain; and the Rev. T. R. R. Stebbing discussed the report of the International Zoological Congress on Nomenclature.

The final report of the Oyster Committee was presented by Prof. W. A. Herdman, who gave an account, illustrated by lantern slides, of the chief conclusions arrived at. The report ends with the following recommendations:—

(*a*) That the necessary steps should be taken to induce the oyster trade to remove any possible suspicion of sewage contamination from the beds and layings from which oysters are supplied to the market. This could obviously be effected in one of two ways, either (1) by restrictive legislation and the licensing of beds only after due inspection by the officials of a Government Department, or (2) by the formation of an association amongst the oyster-growers and dealers themselves, which should provide for the due periodic examination of the grounds, stores and stock, by independent properly qualified inspectors. Scientific assistance and advice given by such independent inspectors would go far to improve the condition of the oyster beds and layings, to reassure the public, and to elevate the oyster industry to the important position which it deserves to occupy.

(*b*) Oysters imported from abroad (Holland, France, or America) should be consigned to a member of the Oyster Association, who should be compelled by the regulations to have his foreign oysters as carefully inspected and certificated as those from his home layings. A large proportion of the imported oysters are, however, deposited in our waters for such a period before going to market that the fact of their having originally come from abroad may be ignored. If this period of quarantine were imposed upon all foreign oysters, a great part of the difficulty as to inspection and certification would be removed.

(*c*) The grounds from which mussels, cockles and periwinkles are gathered should be periodically examined by scientific inspectors in the same manner as the oyster beds. The duty of providing for this inspection might well, we should suggest, be assumed by the various Sea Fisheries Committees around the coast.

Dr. H. Lyster Jameson exhibited examples of a race of protectively coloured mice that inhabit a sandy island in the Bay of Dublin, known as the North Bull. A considerable percentage of these mice are distinctly lighter in colour than the ancestral type (*Mus musculus*, Linn.). Every possible intergradation, however, occurs between the typical house mouse and the palest examples. Mr. Jameson considers the marked predominance of sand-coloured examples as due to the action of natural selection. The hawks and owls, which frequent the island and hunt by "sight," are the only enemies the mice have to compete against, and they most easily capture the darkest mice; that is to say, the mice that contrast most strikingly with the colour of the sand; and thus by the weeding out of the dark-coloured examples a protectively coloured race is becoming established, which, however, has not yet settled down into the comparative stability which usually characterises species.

A reference to old charts and Parliamentary papers has shown that this island first came into existence about a century ago; consequently it is in this case possible to fix a time limit within which the race in question has been evolved.

Monday, September 12.—The Section opened with an interesting account, by Prof. Poulton and Miss C. B. Sanders, of an experimental inquiry into the struggle for existence in certain common insects. A large number of lepidopterous pupæ were exposed under various conditions at Oxford, in Switzerland, and in the Isle of Wight, in order to test by experiment the amount of destruction by birds and other enemies, and also to determine what amount of protection was afforded by coloration. The results showed that there is a heavy death-rate in the pupal condition, and apparently that there is a greater destruction of pupæ at Oxford than in Switzerland. An interesting discussion followed, in which Sir John Lubbock, Prof. Lankester and Prof. Meldola took part. Miss Sanders described and demonstrated with specimens the actual details of the experiments and observations.

Prof. Lloyd Morgan followed with a paper on animal intelligence as an experimental study, which dealt largely with the results of Mr. Thorndike's experiments in America with cats. It was shown that the cats, in opening the doors of ingeniously devised cages, learned gradually by experience, and were not able to profit by imitation. This performance of purposive acts, learned as the result of chance experience, was characterised as intelligent in contradistinction to rational. Prof. Morgan expressed the opinion that without the record of the genesis of an intelligent action observation and anecdote of animal intelligence are of little importance; and in answer to Sir John Lubbock, and others who spoke in the discussion, he stated that the advantage of simple experiments, such as those of Thorndike, over observations, is that the results can be readily expressed in curves.

Dr. A. J. Harrison read a paper on his own observations in the Clifton Zoological Gardens, on the so-called fascination of snakes. The animals dealt with were pythons, both adult and young; and it was shown that in captivity, at least, there was no evidence that they possessed the power of fascinating their living prey, such as hens, ducks and rabbits.

Prof. O. C. Marsh gave a paper on those families of the Dinosauria, which he has called Sauropoda—such as Ceteosaurus and its allies—upon which he has a memoir ready for publication.

Dr. Masterman read a paper by Prof. McIntosh on the scientific experiments to test the effects of trawling in the waters of Scotland from 1886 to 1897. The areas dealt with were St. Andrews Bay, the Firth of Forth, and the Moray Firth, and Prof. McIntosh gave his reasons for dissenting from the conclusion drawn from the work of the Fishery Board for Scotland, that the closure of areas against trawlers had led to an increase in the fish population.

The remaining papers were:—A new theory of retrogression, by Mr. G. A. Reid; the structure of nerve cells, by Dr. G. Mann; and a circulating apparatus for use in researches on colour physiology and other purposes, by Messrs. F. W. Gamble and W. F. Keeble.

Tuesday, September 13.—The following papers were taken:—Mr. R. I. Pocock, on musical organs in spiders; Dr. A. T. Masterman, on the origin of the vertebrate notochord and pharyngeal clefts; Prof. Ch. Julin, on "Le développement du cœur chez les Tuniciers—quelques considérations sur la phylogénie des Ascidies simples"; Mr. W. E. Hoyle, on Dr. Field's card-catalogue of zoological literature; Mr. F. A. Bather, on the classification of the Pelmatozoa; Prof. A. B. Macallum, on the detection of phosphorus in tissues; and two reports of Committees, one on the physiological effects of peptone and its precursors when introduced into the circulation, and the other on the exploration of caves in the Malay Peninsula.

Prof. Julin in his paper dealt with the formation of the heart from the epicardium and its homology with the stolon. He showed reasons for regarding *Distaplia* as a central form linking the other compound ascidians to the simple ascidians through the Clavelinidæ.

The Peptone Committee report that their experiments make it appear probable that peptones and albumenoses are not wholly foreign substances to the circulating blood. It is, however, uncertain to what extent any given substance introduced into the circulation is again recoverable from the urine, and how long such substances can retain their identity after being so introduced. Anti-peptone seems to remain in the system to a much greater extent than any of the other substances employed.

As Section I did not meet this year, but was supposed to be incorporated with D, several of the papers and reports—such as the one last mentioned—were of a physiological nature.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE Geographical Section at Bristol was as a rule well attended, and on one occasion crowded; but, as happens too frequently, the audience had a tendency to vary inversely as the scientific value of the communications submitted to it. Yet on the whole the twenty-five papers read were of high quality, and some of them represented original work in research as well as in travel. The President, Colonel George Earl

Church, formerly of the United States Army, gave an address full of original observations on the central parts of South America, in the course of which he traced the origin of the main features of that continent. This address as printed is enriched with a series of maps and diagrams.

Seven important papers were read on various branches of physical geography, most of them being illustrated by lantern slides. Mr. Vaughan Cornish discussed wave-forms, giving the preliminary results of a research in which he is engaged on the phenomena of waves in water, air, and drifted sand. The results were made clear by a large number of carefully selected photographs and diagrams.

Mr. H. N. Dickson gave a brief account of his work on the salinity and temperature of the North Atlantic, which promises to produce results of great value. His paper described the first results of a discussion of observations of surface temperature made in the North Atlantic, during the two complete years 1895 and 1896, by the captains and officers of merchant ships. The captains of a number of the vessels also collected daily samples of surface water, and the densities of these, numbering about 5000 in all, have been determined by chlorine titration. The material has been found sufficient to allow of the construction of charts showing the distribution of temperature and salinity over a large part of the area during each of the twenty-four consecutive months. The series, which is the first of its kind, shows the progressive changes in the manner of synoptic charts, and provides the data necessary for extending the work recently done in and around the North Sea, in connection with sea-fisheries and long-period weather forecasting. Specimens of the maps were shown on the screen.

Dr. K. Natterer, of Vienna, submitted the oceanographical results of the Austro-Hungarian Deep-Sea Expeditions in the Eastern Mediterranean, Sea of Marmora, and Red Sea. He referred especially to his own chemical observations and the deductions made from them. Of these the most striking was the presumption that the salt-deposits of arid regions surrounding a deep sea were due to the evaporation of sea-water raised by capillarity through the substance of the rocks.

A report by Mr. E. G. Ravenstein was presented on behalf of the Committee for the investigation of the climatology of Africa. The efforts of this Committee during the last seven years have resulted in inducing a number of the African colonial governments to institute regular meteorological observations, and the Committee feels that it is no longer necessary to supply instruments to unofficial observers, although several of the sets supplied to missionaries and others have led to the compilation of important records.

Dr. J. W. Gregory discussed the theory of the arrangement of oceans and continents on the earth's surface in the light of geological and physical observations, He pointed out that Elie de Beaumont's famous scheme attached undue importance to linear symmetry and was too artificial. It led, however, to the tetrahedral theory of Lowthian Green, which regards the world, not as shaped like a simple tetrahedron, but as a spheroid slightly flattened on four faces. Such flattenings occur on hollow, spherical shells, when they are deformed by uniformly distributed external pressure. The oceans would occupy the four depressions thus produced, and the land masses occur at the angles and along the edges. The existing geographical arrangement is in general agreement with this scheme; for as the tetrahedron is hemihedral the assumption that the lithosphere is tetrahedral explains the antipodal position of land and water, the excess of water in the southern hemisphere, and the southward tapering of the land masses. The main lines of the existing system of fold-mountains have a general agreement with the arrangement of the edges of a tetrahedron. Some striking deviations occur, but are explicable by the variations in the composition of the lithosphere, and the existence of impassive blocks of old strata which have moulded the later movements. The lines of the old fold-mountains of the Hercynian system may have been tetrahedrally arranged, with the axes occupying different positions from those of the great Cainozoic mountain system. So far, however, there is no completely satisfactory theory of geomorphology, for which we must wait for further information as to the distribution of land and water in successive epochs of the world's history.

Two important papers on earthquake phenomena were read—one by Prof. J. Milne, F.R.S., on the methods and utility of seismological research; the other by Mr. R. D. Oldham, on the great Indian earthquake of June 12, 1897, which was the largest and, with a few possible exceptions, the most violent of which there is any record. The area over which the shock was sensible was not less than 1,750,000 square miles, while the focus occupied an area of 200 miles in length and 50 miles in width. Landslips on an unprecedented scale were produced in the Garo and Khasia hills, and in the Himalayas north of Lower Assam. A number of lakes have been produced by changes of level due to the earth-movements by which the earthquake was caused, and the mountain peaks have been moved both vertically and horizontally. Monuments of solid stone and forest trees have been broken across by the violence of the shaking they have received. Communications of all kinds were interrupted; bridges were overthrown, displaced, and in some cases thrust bodily upwards to a height of as much as 20 feet, while the rails on the railways were twisted and bent. Earth fissures were formed over an area larger than the United Kingdom, and sand rents, from which sand and water were forced in solid streams to a height of 3 to 5 feet above the ground, were opened in incalculable numbers.

Dr. J. Scott Keltie in a short paper on "political geography" laid stress on the way in which natural conditions determined the manner of the relations between land and people, and showed how changing economic conditions produced corresponding changes in political geography, *e.g.* the formation of such forms as spheres of influence and leased territories. A paper by Mr. G. G. Chisholm, on the impending economic revolution in China, enforced by a concrete instance of great practical importance some of the theoretical considerations brought forward by Dr. Keltie.

Mr. H. T. Crook, of Manchester, criticised the methods of selecting place-names for the Ordnance Survey Map, and brought forward several errors in the sheets of the new one-inch map of the Manchester district. The paper gave rise to a lively discussion, in which Mr. G. F. Deacon supported the contention of the author; while Colonel Farquharson and Sir Charles Wilson, the present and late Directors-General of the Survey, fully explained the methods employed and showed the enormous difficulties with which the whole question of place-names is surrounded. They stated that the Survey always welcomed criticism, and that corrections were frequently made on the plates as the result of information sent by people in the localities when mistakes occurred. It was suggested that the public could aid in the production of good maps more effectually by communicating with the Survey Office than by writing critical articles in the press.

A group of papers submitted to the Section dealt with geographical developments of the future. Prof. Reclus brought forward his scheme for a great terrestrial globe on the scale of 1 : 500,000, or about 84 feet in diameter. The surface of this globe should exhibit the relief of the lithosphere on a true scale, and separate plates of it would be available for use as relief maps upon a surface showing the natural curvature. M. Reclus spoke with great eloquence of the scientific and educational advantages of his scheme, the initial cost of which, however, could not fall far short of 50,000*l*. In the discussion Sir Richard Temple spoke in support of the work being carried out, and a Committee of Section E was appointed by the General Committee to consider and report upon the scientific value of the proposal.

Prof. Patrick Geddes described an interesting experiment in the practical teaching of geography about to be tried in Edinburgh, where he is fitting up an "outlook tower" or geographical museum of a novel character. Thus the exhibition of the ground-floor centres round a globe with an outline survey of the main concepts of world geography—*e.g.* an incipient collection of maps and illustrative landscapes, an outline of the progress of geographical discovery and of map-making, &c. The first floor is devoted to the geography and history of Europe in correspondingly fuller treatment; the second is set apart for an outline geography and history of the English-speaking world, the United States having a room on the same level as the British Empire. On the third story is preparing a corresponding survey of Scotland, viewed at once as an historic and social entity and as an element of greater nationality; while the fourth story, naturally as yet in the most advanced state of preparation, is a museum of Edinburgh, though again not without comparison with Scottish and other cities. The flat roof bears a turret of culminating outlook with a *camera obscura*. Descending from the roof to the upppermost story, this succession and unity of the physical, organic and social conditions is better understood.

Thus the relief model of the site of Edinburgh brings indispensable light on the interpretation of the antique and the modern city, its military history or its industrial present, its medical eminence or its picturesque interest. Similar regional towers should be erected in all large towns. A tower as a memorial to Cabot was recently opened in Bristol, presenting some features which might be developed on the lines of Prof. Geddes' conceptions, but no reference was made to it at the meeting of Section E, nor was the Section invited to visit the tower.

Ballooning as an aid to geographical exploration was discussed by Captain B. Baden-Powell, of the Scots Guards, who outlined a well-considered scheme for an experimental balloon voyage up the Nile valley, where the meteorological conditions are more favourable than those of the Arctic regions, and the chances of disaster more remote. Mr. Eric Stuart Bruce exhibited a method of flash signalling by means of an electric lamp enclosed in a transparent balloon, which he believes to be of special value in polar exploration.

Dr. H. R. Mill discussed the prospects of Antarctic research, tracing the historical changes of the Antarctic problem, and pointing out that the purely scientific importance of south polar exploration demands co-operation amongst simultaneous expeditions rather than consecutive work. He hoped that the definite refusal of Government to take up the work would now leave the way clear for the immediate organisation of a great expedition by the British nation to co-operate with the German expedition which has been planned for 1900.

While the characteristic of this meeting was undoubtedly the solid value and good discussion of the general papers, it in no way fell short of the meetings of preceding years in the interest and value of the records of personal exploration. Mrs. Bishop gave a remarkable paper describing her recent journey in the Yangtze valley, and summarising the geography of that important region. It was illustrated by a series of unique photographs taken by Mrs. Bishop herself. Mrs. Theodore Bent also contributed a paper describing her visit to Sokotra, in the course of which she made valuable observations. A Committee, with a small grant in aid of the further exploration of Sokotra by Dr. H. O. Forbes, was appointed by the Association.

Sir Charles Wilson gave an address on the Upper Nile region with reference to the re-conquest of the Sudan; and, in the absence through illness of the author, he also read a paper, by Sir T. H. Holdich, on Tirah, which was splendidly illustrated by slides. Mr. C. W. Andrews, of the Natural History Museum, gave a preliminary account of Christmas Island in the Indian Ocean, where he has recently spent the greater part of a year. He found it to be an upraised coral island, the coral limestone resting on a hard foraminiferal limestone, which in turn is based on basalt. The whole island is so densely jungle-clad that it could only be traversed at the rate of one mile per day, every yard having to be cut through the dense undergrowth. Captain G. E. H. Barrett-Hamilton described a recent visit he had made to Karaginski Island and the mainland of northern Kamchatka, and Mr. O. H. Howarth added another to his important series of papers on the exploration of Mexico, dealing on this occasion with a journey from Mazatlan to Durango across the Sierra Madre.

It may be pointed out as a disappointing feature at the meeting, that no effort appears to have been made to place before the Section any account of the remarkable geographical position of Bristol with respect to site, immediate surroundings, or commercial position in the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. W. BECKIT BURNIE has been appointed to the vacant Senior Demonstratorship in Electrical Engineering at the South-Western Polytechnic, Chelsea. Mr. Burnie has studied at the Nottingham University College; under Prof. Ayrton, at the Central Technical College; and under Prof. Weber, of Zürich.

DR. M. C. SCHUYTEN, rue van Luppen 31, Anvers, invites teachers who are daily engaged in instructing children to make notes upon the characteristics of the minds of their pupils, and send them to him for incorporation in a work to be published by a special commission upon the psychology of the child from a pedagogic point of view.

THE foundation-stone of a new Science and Art School for Deptford was laid in New Cross Road on Saturday. The new school is the result of an amalgamation by the Charity Commissioners of two ancient charities—the Addey and the Stanhope—and the joint school is to be known as the Addey and Stanhope Foundation. The new building will cost for erection 10,000*l.*, and for furniture and fittings about 4000*l.*

A COURSE of twenty-four lectures and practical demonstrations on the theory and practice of photography, by Mr. W. J. Pope and Mr. A. A. Donald, commenced on Friday last at the Goldsmiths' Institute, New Cross. Mr. Pope is giving a course of twenty-eight lectures on metallurgy, and a course of laboratory instruction on methods of water analysis commenced on Wednesday, October 5. The course will extend over twelve evenings, and the students will obtain practice in the chemical methods ordinarily used to ascertain the degree of purity of water and its suitability for various manufacturing and domestic purposes.

IN an address delivered to the members of the London School Board on Thursday last, Lord Reay, the Chairman of the Board, remarked: Training in physics is found to be preferable to chemistry, and the laboratories now in construction are, as a rule, so fitted as to be adapted to the teaching of physics rather than for specialised instruction of chemistry. Geography in the past has been taught too mechanically. Map-drawing has been revived and greatly improved, but more attention should be given to physical geography, to the great phenomena of nature, to the laws influencing climate, productiveness of soil, &c. History should be connected with geography, and the lessons should be given in such a manner as to make history and geography illustrate each other.

THE Directors of Nobel's Explosives Company, Limited, after consultation with Dr. G. G. Henderson, Freeland Professor of Chemistry in the Glasgow and West of Scotland Technical College, have decided to give a prize tenable under the following conditions: (1) The prize to be 30*l.* and to be known as the "Nobel Company Prize." (2) The prize to be awarded annually, until further notice, to a student in the chemical laboratory of the Technical College, who has passed through the usual course of training in that laboratory, and who, in the opinion of the Professor of Chemistry for the time being, is qualified to prosecute research. (3) The holder of the prize to engage in research work in the chemical laboratory of the Technical College, under the direction of the Professor of Chemistry for the time being, for the period of one academical year. (4) The prize to be awarded by the Professor of Chemistry for the time being. In accepting the gift, the Governors of the College further resolved to grant a free studentship for one year in the laboratory to the Nobel Company's prizeman, thus raising the money value of the prize to about 50*l.* The example of Nobel's Company might profitably be followed by other chemical manufacturers.

THE Scotch Education Department has issued a circular in further explanation of the scheme of organised science instruction in various classes of schools recently proposed (see p. 408). The schemes proposed in aid of systematic instruction based upon the teaching of science, or in which science is a predominant element, are two—viz. (1) the scheme for higher grade (science) schools, and (2) the scheme for schools of science defined in the Science and Art Directory. The former is especially designed to apply to secondary departments, which, while possessing a distinct organisation, are connected with schools aided under the Education Code, which possesses the necessary equipment for giving practical instruction in science, and in which the predominant aim is intended to be scientific. It is thought that the scheme provides a course of instruction specially suitable for pupils leaving school at the age of fifteen or sixteen, who will in after life for the most part follow industrial or commercial pursuits. Having regard to the increasing importance of a thorough training in science, especially in large industrial centres, the circular points out that schools of science should by preference be absolutely independent institutions, having their own premises, equipment, and staff, in which instruction in science can be carried to a much higher point than obtains at present; and it is hoped that such schools of science, in the proper sense of the term, will be before long established in the large towns. But for the present, on good cause being shown, the existing practice of recognising, as schools of science, the science sides or departments of secondary schools, will not be departed from. The science side must, however, be clearly separated from the classical or language side of such schools. In view of the presumably greater age of pupils in a secondary school, it will be required, as a condition of the continued recognition of a school of science, that a considerable proportion of the pupils shall proceed to the advanced course; and the inspectors will be directed to make strict inquiry into the reasons which prevent pupils who have enteted upon the course, and are still in attendance at the school, from completing the curriculum.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 3.—M. Van Tieghem in the chair.—The analysis of some commercial specimens of calcium carbide, by M. Henri Moissan. If calcium carbide is prepared from impure materials, it is liable to contain calcium phosphide and aluminium sulphide, both decomposable by water, giving hydrogen phosphide and sulphide respectively. In the residue left after treatment with water, besides lime, there is found calcium, iron, and carbon silicides, calcium sulphide, and sometimes graphite. Crystals of silica are also present, but a careful search for diamonds gave negative results in all the samples examined. The acetylene produced by the action of water upon the carbide contains traces of sulphur compounds other than sulphuretted hydrogen.—Increase of weight of the body, and the transformation of fat into glycerine, by M. Ch. Bouchard. In the course of some observations upon the changes of weight in a man placed under such conditions that the only *ingesta* conld be atmospheric air and the only *excreta* moisture and carbonic dioxide, a distinct gain of weight was observed. Repetitions were made confirming this, the gain being on one occasion as much as 40 grams per hour. After a discussion of the possible ways of accounting for this increase, the conclusion is drawn that the only probable explanation is to be sought in the conversion of fat into glycogen, according to the equation

$$C_{55}H_{104}O_6 + 30O_2 = 12H_2O + 7CO_2 + 8C_6H_{10}O_5.$$

Experiments made on animals fed with fatty diet confirmed this view.—On the distribution of farm manure, by M. P. P. Dehérain. An experimental study of the losses of ammonia and carbonic acid by farm manure exposed to intermittent currents of air.—Observations of the planet DQ Witt (August 13), made with the large equatorial of the Observatory of Bordeaux, by MM. Rayet, L. Picart, and F. Courty.—On interscapulo-thoracic amputation in the treatment of malignant tumours of the upper extremity of the humerus, by M. Paul Berger. In both the cases operated on by the author a radical cure was effected, the recovery being very rapid. Out of forty-six cases of this operation on record, only two were attended with fatal results.—Observations of comets made at the Observatory of Rio de Janeiro, by M. L. Cruls.—Observations of the 1898 Comet (Perrine-Chofardet), made at the Observatory of Besançon, by M. L. J. Gruey.—On a class of contact transformations, by M. E. O. Lovett.—On the preparation and properties of the double carbides of iron and chromium, and of iron and tungsten, by M. Percy Williams. A mixture of chromium oxide (200 gr.), iron (200 gr.), and carbon (70 gr.) is heated in the electric furnace for five minutes with a current of 900 amperes and 45 volts. The carbide can be isolated from the fused mass in metallic needles, having the colour of nickel. A double carbide of iron and molybdenum is obtained in a similar manner. The formulæ of these compounds are $3Fe_3C.2Cr_3C_2$ and $Fe_3C.Mo_2C$.—New combinations of phenylhydrazine with certain metallic salts, by M. Pastureau. Combinations of phenylhydrazine with $BiCl_3$, $Bi(NO_3)_3$, $ZnSO_3$, and $MnSO_3$ are described.—On the vivipary in an annelid (*Dodecaceria concharum*), by MM. Félix Mesnil and Maurice Caullery.—On the tactile impression due to the contact of a succession of reliefs representing a mobile object in its different positions. With practice it is possible to rapidly recognise a relief by touch, and if a series of reliefs follow each other at a certain rate, the effect of movement is obtained. Thus the motion of the flight of a bird may in this way be imparted to the blind.

BOOKS, PAMPHLET, SERIALS, &c., RECEIVED.

BOOKS.—Skiagraphic Atlas: J. Poland (Smith, Elder).—Seismology: J. Milne (K. Paul).—A Tieatise on Dynamics of a Particle: Dr. E. J. Routh (Cambridge University Press).—L'Année Biologique, 1896 (Paris, Reinwald).—In the Forbidden Land: A. H. S. Landor, 2 Vols. (Heinemann).—Reliquary, Vol. iv. (Bemrose).—Qualitative Chemical Analysis Chapman Jones (Macmillan).—A History of Chemistry: Prof. E. Von Meyer, 2nd edition, translated by Dr. G. McGowan (Macmillan).—The Illustrated Annual of Microscopy (Lund).—Uber die Theorie des Kreisels: F. Klein und A. Sommerfeld, Heft 2 (Leipzig, Teubner).

PAMPHLET.—Report on the San Jose Scale in Maryland: W. G. Johnson (College Park, Md.).

SERIALS.—Kew Bulletin, October (London).—Reale Istituto Lombardo, Rendiconti, Serie 2, Vol. xxxi Fasc. 15 and 16 (Milano).—Imperial University, College of Agriculture, Bulletin, Vol. 3, No. 4 (Komaba, Tokyo).—Mind, October (Williams).—Journal of the Royal Statistical Society, September (Stanford).—Engineering Magazine, October (Strand).—Geographical Journal, October (Stanford).—Atlantic Monthly, October (Gay).

Philip's Celestial Globe (Philip).—Philip's Popular Globe (Philip).

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