THURSDAY, APRIL 16, 1874

THE ADAPTATION OF OUR UNIVERSITIES TO THE WANTS OF THE AGE

IT has given us special pleasure during the last few years to record the efforts made in several of our British Universities and Colleges to adapt their teaching and their appliances for teaching to the present state of knowledge. We have seen what has been done by means of a fraction of the splendid revenues of Oxford, what the princely munificence of her Chancellor is providing for Cambridge, and what public subscriptions aided by judicious liberality on the part of Government have enabled Glasgow to achieve. Let us see what is now being attempted by a University which, though for its years rich in usefulness and fame, even relatively to those just mentioned, is, so far as funds are concerned, in a state approaching to indigence.

A short paragraph in our last number called the attention of our readers to the important step which has just been taken by the University of Edinburgh, with the view of thoroughly adapting its lecture-rooms and laboratories at once to the enormously increased numbers of its teachers and students, and to the ever-growing demands of physical and biological science.

Increase of numbers of teachers and taught would of itself demand a proportionate increase of space, which in Edinburgh must be considerably more than two to one as regards lecture-rooms alone. But when we consider the improvements which have been introduced into the modes of teaching, the imperative necessity for *practical* instruction in addition to lectures and demonstrations; nay more, the desirability of enabling professors not merely to teach what is known, but also, by original research conducted by themselves and their more promising students, to endeavour to extend the boundaries of Science: we see how immense are the issues involved in the step which Edinburgh has just taken.

That it will be successful, no one who knows Scotland and Scotsmen can for a moment doubt. But Scotland is a comparatively poor country—receiving back from the Treasury a much smaller fraction of her taxation than more favoured portions of the empire—and Edinburgh University is, relatively to the number of her students, by far the poorest of even the poor Scottish Universities. It is to be hoped, therefore, that Government aid will be forthcoming, as in the recent case of Glasgow, to eke out the efforts of those who, with as good a cause as could be wished for, and hearty desire to advance it, yet cannot entirely rely on the results of their unaided exertions. All former Edinburgh *alumni*, scattered as they are broadcast over the world, especially in England and in India, must be prepared to acknowledge, by such contributions as they can afford to make, the value of the instruction they have received. Let no one abstain from giving because of the smallness of the sum he can afford; every mite is of importance—let him rather rejoice that he has the opportunity, which appears to occur but once in a century, of contributing to so noble an object.

The story of her last successful endeavour to meet wants to a certain extent akin to those now felt is well told in the following extract from the Programme of the Acting Committee:—

"One hundred years ago, an Appeal was made to the public on behalf of the University of Edinburgh. The number of students was then stated as 'betwixt six and seven hundred,' the inadequacy of the collegiate buildings to the size and importance of the University was pointed out, and it was declared that while in Edinburgh great improvements were going forward on all hands, 'the University fabric alone' remained 'in such a neglected state, as to be generally counted a dishonour to the City of Edinburgh, and to this part of the kingdom.'

"The result of that Appeal was a liberal public subscription, opened in March 1768, which, with the aid of Government, provided the handsome edifice now existing. That building for a long period amply sufficed for all the teaching purposes of the University. But the lapse of a century has produced great changes. During that period the population of the metropolis has been more than trebled; increased facilities for travelling have brought the University within easy reach of all parts of the country; the advantages of a University education have become much more appreciated; the advancement of Science has widely extended the field of academic teaching; and the renown alike of teachers and graduates, whose names will ever be associated with the University of Edinburgh, has increased its fame and reputation throughout the world.

"Thus, the buildings of the University again prove to be wholly inadequate to its necessities. This inadequacy is felt in various ways.

"The number of students attending the University in 1768 was 'betwixt six and seven hundred,' and the number of Professors was 21. In the present Session (1873-4) the number of students is between 1,900 and 2,000, and that of the Professors is 35. The Class-room accommodation has thus become wholly insufficient. The students at present attending the Chemistry, Anatomy, and Natural History Classes number about 300 in each case. The Lecture-rooms are consequently much overcrowded, and great personal discomfort is thus occasioned to both the teachers and the taught.

"But apart from the present buildings being insufficient as regards the students in attendance, the nature of the modern system of teaching in several branches has rendered the existing accommodation altogether unsuitable.

"Since the present University buildings were erected, the whole subject of Practical Chemistry has been added to the course of study. Within the last ten years large and commodious laboratories have been provided in connection with many of the European Universities, and it would be most unfortunate if the University of Edinburgh, which was the first British school to introduce practical instruction in Chemistry into the medical curriculum, were not enabled to carry on satisfactorily this important branch of medical and scientific training.

"Again, the instruction formerly given in Anatomy consisted almost entirely of lectures and demonstrations delivered in the class-room. The changes in Medical education during the last thirty years render it necessary that each student should now pursue for himself the study of Practical Anatomy. The rooms at present in use were not constructed for that purpose, and are lamentably inadequate for the work to be done in them.

"But besides the departments of Chemistry and Anatomy, increased accommodation, in the form of Laboratories, and rooms suited for microscopic and other practical investigation and instruction, is required for the Chairs of Materia Medica, the Institutes of Medicine, Natural History, and Pathology. Nor is it less urgent that much additional accommodation for the apparatus and the Physical Laboratory of the Chair of Natural Philosophy should be provided."

Take these in turn—the last-mentioned first. The Physical Laboratory has been but six years in existence; simply because it was impossible sooner to find any accommodation for it. One small room was obtained capable of holding a dozen students (at very high pressure). The success of the first year was so great that in the next session more than half of the applicants had to be refused admission; and as the demand grew, the working time allowed each student per day had to be further and further restricted, till, in the session just concluded, the lowest admissible limit (*one hour per day*) had at first to be adopted, and yet several applications for admission had to be refused. In spite of these drawbacks, much sound work has been done, and many of the Laboratory students have already obtained excellent posts connected with Astronomy, Telegraphy, Engineering, Sugar-refining, &c., mainly on account of the training they have received. The good thus done is to be measured, not by the mere fact of the success of these men in life, but by the fact that their success introduces into practical observatories, workshops, &c., men who have learned the reasons for the manipulations they employ, and who can therefore meet an emergency in ways which no rule-of-thumb teaching could possibly have suggested.

In Anatomy and Chemistry, practical teaching has long been established, and is afforded to every medical student and to such others as study these subjects as parts of a general scientific training. But it is necessary that a great deal more should be done in this direction, especially in the way of affording to advanced students opportunities of cultivating their own powers, and furthering Science by original research. The present arrangements render this possible only to a very limited extent.

Although practical instruction in Physiology, Pathology, and Pharmacology have not formed for so long a period as in Anatomy and Chemistry an integral part of a medical curriculum, yet the University authorities have recognised its importance and have introduced it as far as the meagre space at their disposal would admit. But the increasing demand for a practical training has overcrowded these rooms and made it imperative that additional accommodation should be provided, not only for tuition but for self-training and discovery.

Thus all the practical departments in both the physical and biological sciences urgently demand additional houseroom.

In conclusion, we would again call attention to the fact that one of the great reasons for the present appeal is to be found in the immense success of the University; its mere numerical growth has far exceeded the accommodation provided. But we would also specially note the fact that, although the scheme has just been launched, the contributions already received or promised amount to the very handsome, though of course utterly inadequate, sum of 60,000*l*. At least 40,000*l*. more, with the equivalent which may reasonably be expected from Government, are required to give us yet another University, furnished at least with buildings which will enable it to preserve for another century its well-deserved but hardly-won fame.

But it must not be forgotten that buildings alone, however perfect, are not sufficient for the work desired. The further extension of the teaching staff must inevitably follow. But questions of this nature, as well as the annual supply of funds for the purchase of apparatus and materials, will, we hope, be effectively treated by the Royal Commission on Science, whose Report on the Scottish Universities, and whose proposals for their adequate endowment, are, in the North at least, anxiously expected.

SCHORLEMMER'S "CHEMISTRY OF THE CARBON COMPOUNDS"

A Manual of the Chemistry of the Carbon Compounds; or, Organic Chemistry. By C. Schorlemmer, F.R.S., Lecturer on Organic Chemistry in the Owens College, Manchester. (London: Macmillan and Co, 1874.)

JUDGING from the rapidity with which text-books on Organic Chemistry have made their appearance of late, it might reasonably be inferred that a good treatise on that subject is much wanted. The student who turns eagerly to the present manual in the hope that the eminent author will help him out of some of his difficulties, and that he will find the subject treated in a novel manner, will however, we fear, feel somewhat disappointed.

The classification adopted by the author deals first with the compounds of carbon with oxygen, sulphur, and nitrogen; compounds which form the connecting link between inorganic and organic chemistry. He considers, justly, that a knowledge of the compound radicals into which these elements enter is essential to a proper understanding of a large number of other carbon compounds. He then describes the large group of fatty substances, subdivided again according to the quantivalence of their radicals, as well as the carbohydrates, terpenes, and camphors. The next division comprises compounds richer in carbon than the fatty substances, and which are not converted into such by the addition of hydrogen. These are again subdivided into several groups, including that of the aromatic compounds, which has been most fully investigated, and the group of compounds containing two or more aromatic nuclei linked together by carbon, and the glucosides. Lastly, we have a division of artificial and natural bases (alkaloids), of colouring and bitter principles, of compounds contained in bile and other secretions of the animal body, and of albumenoids and proteids.

It will be seen from this brief synopsis that the author deviates for the most part from the arrangement which has found favour with many modern writers on Organic Chemistry. Rather than treat of well-defined families of organic bodies, such as hydrocarbons, alcohols, ethers, aldehydes, ketones, acids, &c., he prefers to retain groups of homologous series, together with their derivatives. To the student this arrangement has the decided drawback that it involves much repetition in examining chemical changes, and, what is more important, it does not enable him to take in at a glance in what consists the similarity or dissimilarity between classes of bodies of analogous structure, and derived from a homologous parent stock; nor is it so easy to see where one or several links in the various homologous series are missing. The reward of grappling with the intricacies of organic bodies to which each worker is entitled who adduces new facts—no matter to how limited an extent—consists just in the intellectual treat of supplying perhaps some of these many missing links. There can be no question which system of classification will assist him to do this most speedily.

A student's perplexity will not be diminished on following our author into the vexed question of formulæ. We take it for granted that chemical formulæ have been devised to express the phenomena produced by the action of chemical force. That they express at present the final results rather than the agencies and forces which have been at work to produce them may likewise be taken as correct. They are, at the very best, poor representations only of the chemical changes which we witness daily. Whether it will ever be possible to prove that the atoms or groups of atoms of which chemical compounds are supposed to consist really stand to each other in certain definite relations, because they exhibit certain analogies under the influence of the chemical force which holds them together or loosens them, may well remain matter for speculation. As long as no differences of opinion respecting chemical facts are involved, views may differ on the mode of expressing them by formulæ, provided always that the choice between two different modes of expression falls upon the one which recalls the greatest number of analogies in the most simple and rational manner, and can therefore become more fruitful in new discoveries. Several rational formulæ are possible for one and the same compound according as different relations are to be expressed. A knowledge of the order or position of the atoms is out of the reach of experimental demonstration. If the so-called position-theory of the carbon atoms in certain organic compounds can assist us, however, in elucidating certain relations and analogies, and if this theory is leading rapidly to numerous new discoveries, then, by all means, let us avail ourselves of it. It seems that constitutional, or, as they are sometimes called, structural formulæ excite the ire of some of our critics of chemical literature inversely to the understanding they display of them, and the very name constitutional formula, or the sight of a graphic representation thereof, inflames their fury as violently as a red cloak excites an infuriated bull. However much ridicule may attach in the eyes of some people to constitutional or structural representation, it is pleasant to observe that the chemists who now dispense with it altogether form the exception rather than the rule.

Mr. Schorlemmer makes an especially liberal use of structural formulæ, showing the relative position and units of combining capacity of carbon atoms, with the view mainly of explaining isomeric bodies. Every student of organic chemistry will thank him for this, for, on perusing the journal of the Berlin Chemical Society, for instance, one cannot help being struck with the remarkable impulse which the conception of structural representation of the chemical composition of bodies has given to the study of organic chemistry in Germany. Chemists find it, no doubt, difficult to disengage themselves entirely from some of the various theories that have held sway during the last twenty years, and hence we look with leniency upon the want of uniformity of formulæ and chemical nomenclature displayed in this book. On pp. 3, 4, and 5, for instance, the brace is used in a double sense, showing the formation of molecular bodies by the direct combination of element with element as in $\left.\begin{matrix}H\\H\end{matrix}\right\}$, $\left.\begin{matrix}H\\Cl\end{matrix}\right\}$, $\left.\begin{matrix}K\\I\end{matrix}\right\}$; and again by uniting two or more elements with a polyvalent element, as in $\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$, without any connection existing between the monad elements themselves other than through the polyad element. Such names as Tin chloride, $SnCl_4$, Platinum chloride, $PtCl_4$, and others, must create the impression that these are the only compounds which tin, &c. forms with chlorine. The different atomic groups in structural formulæ are sometimes separated by points, sometimes by lines (forks, prongs, or whiskers, as some fastidious critics have called them). In the absence of these various graphic representations free use is made of molecular formulæ; indeed it strikes us that the author has been often over-cautious, and has not attempted constitutional formulæ where such representation would appear of particular interest to the student, as, for instance, in the case of the isomers of aldehyde, of aldines, &c.

Certain groups of atoms contained in a great number of organic bodies, such as nitroxyl, NO_2, sulphuryl, SO_2, phosphoryl, PO, *may* be viewed otherwise than as monad, dyad, or triad compound radicals. Why, for instance, should PO in phosphorous acid be a triad radical when one of the hydrogen atoms is not replaceable, but "remains together" with the PO group? or in hypophosphorous acid, where two atoms of hydrogen remain linked to PO? Considering the liberality displayed by the author regarding formulæ, we shall be pleased to see him shake off the trammels which still encumber his inorganic compounds. We cannot see why NO_2 should combine with OH to form nitric acid, and with H to form nitrous acid, or why SO_2 should form the compound radical in $SO_2\left\{\begin{matrix}Cl\\Cl\end{matrix}\right.$ and in sulphuric acid $SO_2\left\{\begin{matrix}OH\\OH\end{matrix}\right.$, and also in sulphurous acid $SO_2\left\{\begin{matrix}H\\OH\end{matrix}\right.$. Our author writes ethyl nitrite $C_2H_5O.NO$, and not $C_2H_5NO_2$, "because in the former the N is linked to the ethyl by means of an atom of oxygen, whilst in the isomeric nitro ethane $C_2H_5N\left\{\begin{matrix}O\\O\end{matrix}\right>$ the nitrogen is linked directly, and the oxygen atoms satisfy each other." We need scarcely say that this latter compound may also be viewed differently. We might greatly extend the list of similar incongruities, taking our examples especially from the organic silicon and boron compounds, which, more than anything else, show that the same idea of grouping elements that is now so freely admitted to prevail for carbon compounds must logically hold good also for inorganic bodies.

The nomenclature first proposed by Hofmann and adopted by our author of designating the different parallel hydro-carbon series by the terminations, ane, ene, ine, one, une has some inconveniences which perhaps are less apparent to the teacher than to the student of organic chemistry, who must be sorely puzzled to distinguish, for instance, between ethine and phosphine, stibine, oxytetraldine, &c.; and it is with regret we see some authors go even further, and substitute, for instance, iodethane for the familiar ethyl iodide, &c.

As constitutional or structural formulæ are intended to assist the student in the study of organic chemistry, we should have preferred if the well-understood abbreviations for compound radicals, advocated by some of our most eminent chemists, such as Et. for ethyl, Ay. for amyl, had been used. We observe, on p. 53, that Cfy. and Cfdy. are used for the compound cyanogen radicals; why should not constitutional formulæ generally be simplified by the use of abbreviations? The task of deciphering certain complex organic formulæ is already heavy enough, and some such shorthand expressions as the above will soon become all but indispensable. We do not for a moment blame the author alone for these sins of omission and commission. Our nomenclature and terminology are in such a state of confusion that a bold reformer should be welcomed rather than discouraged by every lover of our science.

We notice a few slips: On p. 7 "$C_n H_2 + _2$" should be $C_n H_{2n} + _2$; on p. 13 "monad and triad radicals cannot be isolated;" but at top of p. 14 we are told that "methyl combines with methyl, and we obtain ethane or ethyl hydride." Why methyl, &c., should not exist in a free or molecular state as much as hydrogen we are unable to see. On p. 67, the oxygen in the formula for guanidine should be omitted. On p. 72, "methyl iodide $2CH_3$" should be $2CH_3I$. On p. 111, "The vapour of ether is 2·557 times heavier than water." On p. 112 "triacetyl chloride" should be trichloracetyl chloride. On p. 135, "$C_6 H_{12} N$" is given in the equation, instead of $C_6 H_{12} N_2$. On p. 309, "$C_2 H_3 NH_2$" should be $C_2 H_5 NH_2$; and others which we will not mention.

We freely admit many commendable features in Mr. Schorlemmer's new book, which will render it extremely useful, especially to the student engaged in tracing the various isomerides, but we cannot help thinking that in some respects it does not come up to some works on organic chemistry which we already possess.

OUR BOOK SHELF

Dahomey as it Is: being a Narrative of Eight Months' residence in that country, with a full account of the notorious Annual Customs and the Social and Religious Institutions of the Ffons; also an Appendix on Ashantee, and a Glossary of Dahoman Words and Titles. By J. A. Skertchly. (London: Chapman and Hall, 1874).

MR. SKERTCHLY left England in 1871 for the purpose of making zoological collections on the West Coast of Africa. On his arrival at Whydah he was induced to go up to Abomey, the capital of Dahomey, for the purpose of instructing the king, Gelelé, in the use of some guns that had arrived, on the promise that he would be back at Whydah in eight days. The king, however, detained Mr. Skertchly as an unwilling guest for eight months, treating him with the greatest consideration and kindness, and creating him a prince of the country. The greater part of Mr. Skertchly's work is occupied with a description of the protracted annual "customs," as they are called, of Dahomey, which consist of elaborate and harmless trivial ceremonies, mixed up with much that is revolting and cruel; the details of these Mr. Skertchly describes in minute and often tiresome detail. We do not think there was any need for Mr. Skertchly making so large a book on what he saw, especially as the Dahomans and their "customs" are pretty well known through previous travellers. He often questions the accuracy of Burton, who is quite able to defend himself if he feels aggrieved at Mr. Skertchly's criticisms. The author succeeded, during his stay at Abomey, in doing but little in the way of collecting, and in this work there is scarcely any details as to the natural history of the country. He has evidently a considerable admiration both for the Dahomans and Ashantees, especially for the former, whom he considers not nearly so cruel as the latter, though both equally brave and remarkably well-disciplined as soldiers. In a short Appendix on the Ashantees, he prophecies that our recent expedition to the Gold Coast would find them formidable enemies, which prophecy can hardly be said to have been fulfilled. He defends the Dahomans from the charge of intentional cruelty in the barbarously performed human sacrifices which form so important a part of their customs, and we think he succeeds; the victims, who are all either criminals, or prisoners of war, are sent as messengers to deceased kings. The work is illustrated with a number of gorgeously coloured plates, which no doubt show faithfully the dresses and manners of the people, though some of the pictures which exhibit the method of sacrificing the human victims are simply revolting, and ought to have been confined to the author's portfolio.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Fertilisation of the Fumariaceæ

I BEG permission to make a few remarks on Mr. J. Traherne Moggridge's statement (NATURE, vol. ix. p. 423) that the flowers of *Fumaria capreolata* are at first pale or nearly white, and only attain their brightest colouring, becoming even crimson, after the ovaries are set. He then adds:—"If the reverse had been the case there is little doubt that we should have regarded the bright colouring as specially adapted to attract insects." But does Mr. Moggridge know that these flowers are visited chiefly by diurnal insects? It has often been observed that flowers which are visited by moths are commonly white or very pale; but if they are odoriferous, they may be of any tint, even very dark or green. If therefore the flowers of the above Fumaria are visited by moths, it would be an injury to the plant had the flowers been from the first of a fine crimson. I have often seen bees sucking the flowers of the fumariaceous genera, *Corydalis*, *Dielytra*, and *Adlumia*; but many years ago I watched perseveringly the flowers of *Fumaria officinalis* and *parviflora*, and never saw them visited by a single insect; and I concluded from reasons which I will not here give (as I cannot find my original notes), that they were frequented during the night by small moths. Insects are not necessary for the fertilisation of *Fumaria officinalis*; for I covered up a plant, and it produced as many seeds as an uncovered one which grew near. On the other hand, with some species of *Corydalis*, the aid of insects is indispensable. With respect to the flowers of *F. capreolata* becoming brighter coloured as they grow old, we see the same thing in some hawthorns, and with the double rocket in our gardens. But is it surprising that this should sometimes occur with flowers, seeing that the leaves of a multitude of plants assume, as they become oxygenised, the most splendid tints during the autumn?

Down, Beckenham, Kent, April 6 CHARLES DARWIN

IN the vegetable kingdom we meet very commonly with gaily-coloured chemical products, essentially connected with the normal processes of development (the chlorophyll of most non-parasitic plants, the splendid rose pigments of Florideæ, the many lively-coloured pigments of lichens and fungi), and originating from venomous infection by insects (red-coloured galls of oak-leaves) or from decomposition (red pigments in autumnal leaves). In all these cases these colours appear to us to be merely an accidental quality of the chemical products, and we do not feel induced to start the question of what use any particular colour may be to the plant producing it. But it is quite otherwise with the gay colours of flowers. Bright colours in flowers which especially attract our attention and admiration are in most cases beneficial to the plant itself which produces them, by attracting in like manner also the attention of insects, which, visiting the flowers for their own profit, at the same time unconsciously bring to the plant the great advantage of cross-fertilisation. Hence we understand that bright-flowered varieties, whenever produced by any cause, might be preserved by natural selection, and at last remain the only survivors among all the concurrents of the same species. Thus, the occasional appearance of gaily-coloured varieties granted as a matter of fact, and the peculiarities of colour supposed to be hereditable, we are enabled by Darwin's theory to explain the variety of colours met with in flowers. But we should always bear in mind that we are at present quite ignorant of the chemical processes by which certain colours are produced in the flowers, and of the physical or organic causes by which these chemical processes were effected when they first appeared and are effected in every subsequent generation. Reflecting on the first origin of the adaptation of flowers to the cross-fertilisation by insects, and considering that the oldest and most primitive phanerogamous plants which still exist, the Gymnospermæ, are exclusively fertilised by the wind (are *anemophilous*), whilst the enormous majority of Angiospermæ is provided with flowers adapted to cross-fertilisation by insects (*entomophilous*), we cannot doubt that the original manner of fertilisation of phanerogamous plants was fertilisation by the wind, and that the first plants which adapted their flowers to cross-fertilisation by insects were anemophilous ones, either Gymnospermæ or the next descendants of them. Nevertheless the flowers of many Gymnospermæ (Abietinæ) present a beautiful colour, which attains its culmination during the disseminating of the pollen.* This beautiful colour is apparently neither of any use to these plants, which are regularly cross-fertilised by the wind, nor can have been inherited from ancestors to which it was useful. We may therefore also in this case, without hesitation, regard the colour as a merely accidental phenomenon, which, secondarily produced by the more active chemical processes during the time of flowering, disappears again in the same degree as the intensity of development decreases in the cones. Probably the gaily-coloured perianths of the entomophilous Angiospermæ have originated in a similar manner.

Independently of possible physical effects, natural selection is evidently without any influence as to colours, unless animals are attracted or repelled by them. Consequently not only the first origin of bright-coloured flowers, but also the change of colour in the flowers after the ovaries are set, is altogether foreign to the effects of natural selection. It is as indifferent to an entomophilous plant whether its flowers, after having been fertilised, grow paler or darker, as it is to an anemophilous plant whether its flowers are attractive to insects or not. In most cases, indeed, flowers change while fading into paler and less conspicuous colours, but often also their colour remains unaltered or even grows more conspicuous. Old flowers of *Melampyrum pratense*, for instance, which, not having been cross-fertilised by insects, regularly fertilise themselves, are always reddish-yellow, whilst younger ones are yellow.

As to *Fumaria capreolata*, alluded to in Mr. Moggridge's letter (NATURE, vol. ix. p. 423) I have never had the opportunity of observing its flowers myself, but from Hildebrand's account ("Jahrb. f. wissensch. Bot." vii. p. 452) I believe that it is restricted to regular self-fertilisation, cross-fertilisation by insects not, indeed, being impossible, but taking place very exceptionally; for it has lost, probably from permanent disuse, the elasticity of the cap formed by the inner petals, which in other fumitories secures cross-fertilisation in case of the repeated visits of insects. If this presumption of mine be right, it would the more explain Mr. Moggridge's observation; for in this case the colour of the flowers of this fumitory, inherited from ancestors to which it was quite useful, would be almost useless to this degenerated descendant, and therefore almost withdrawn from the influence of natural selection.

HERMANN MÜLLER

Lippstadt, April 4

* See Strassburger's memoir in "Yenaische Zeitschrift," vi. band, 2 heft, pp. 249-261.

Conference for Maritime Meteorology

SOME of your readers may have noticed in the Report of the Proceedings of the Meteorological Congress at Vienna that it was decided to be advisable to convene a fresh Conference for maritime meteorology, in order to reconsider the decisions of the Brussels Conference in 1853.

The matter was handed over to the Permanent Committee, and by them delegated to a sub-committee composed of the following members:—

Prof. Buys Ballot (Holland)
Prof. Mohn (Norway)
Capt. E. Mouchez (France)
Dr. G. Neumayer (Germany)

with myself.

The sub-committee have nearly decided on a form of programme for the proceedings, and there are hopes that the Conference will meet in London in the month of August or so. Endeavours will probably be made to induce H.M.'s Government to issue the invitations, and thereby to give an official character to the Conference.

ROBERT H. SCOTT

Herbert Spencer and *à priori* Truths

ABSENCE from town has delayed what further remarks I have to make respecting the disputed origin of physical axioms.

The particular physical axiom in connection with which the general question was raised, was the Second Law of Motion. It stands in the *Principia* as follows:—

"*The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*

"If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both."

As this, like each of the other laws of motion, is called an axiom;* as the paragraph appended to it is simply an amplification, or re-statement in a more concrete form; as there are no facts named as bases of induction, nor any justifying experiment; and as Newton proceeds forthwith to draw deductions, it was a legitimate inference that he regarded this truth as *à priori*. My statement to this effect was based on the contents of the *Principia* itself; and I think I was warranted in assuming that the nature of the laws of motion, as conceived by Newton, was to be thence inferred.

The passages quoted by the *British Quarterly Reviewer* from Newton's correspondence, which were unknown to me, show that this was not Newton's conception of them. Thus far, then, my opponent has the best of the argument. Several qualifying considerations have to be set down, however.

(1) Clearly, the statements contained in the *Principia* do not convey Newton's conception; otherwise there would have been no need for his explanations. The passages quoted prove that he wished to exclude these cardinal truths from the class of hypotheses, which he said he did not make; and to do this he had to define them.

(2) By calling them axioms, and by yet describing them as principles "*deduced* from phenomena," he makes it manifest that he gives the word axiom a sense widely unlike the sense in which it is usually accepted.

(3) Further, the quotations fail to warrant the statement that the laws of motion are proved true by the truth of the *Principia*. For if the fulfilment of astronomical predictions made in pursuance of the *Principia* is held to be the evidence "on which they chiefly rest to this day," then, until thus justified, they are unquestionably hypotheses. Yet Newton says they are not hypotheses.

Newton's view may be found without seeking for it in his letters: it is contained in the *Principia* itself. The scholium to Corollary VI. begins thus:—

"Hitherto I have laid down such principles as have been received by mathematicians, and are *confirmed* by abundance of experiments. By the two first Laws and the two first Corollaries, Galileo discovered that the descent of bodies observed the duplicate ratio of the time, and that the motion of projectiles was in the curve of a parabola; experience *agreeing* with both," &c.

Now as this passage precedes the deductions constituting the *Principia*, it shows conclusively, in the first place, that Newton did not think "the whole of the *Principia* was the proof" of the

* It is true that in Newton's time, "axiom" had not the same rigorously defined meaning as now; but it suffices for my argument that, standing unproved as a basis for physical deductions, it bears just the same relation to them that a mathematical axiom does to mathematical deductions.

laws of motion, though the Reviewer asserts that it is. Further, by the words I have italicised, Newton implicitly describes Galileo as having asserted these laws of motion, if not as gratuitous hypotheses (which he says they are not), then as *à priori* intuitions. For a proposition which is *confirmed* by experiment, and which is said to *agree* with experience, must have been entertained before the alleged verifications could be reached. And as before he made his experiments on falling bodies and projectiles, Galileo had no facts serving as an inductive basis for the Second Law of Motion, the law could not have been arrived at by induction.

Let me end what I have to say on this vexed question by adding a further reason to those I have already given, for saying that physical axioms cannot be established experimentally. The belief in their experimental establishment rests on the tacit assumption that experiments can be made, and conclusions drawn from them, without any truths being postulated. It is forgotten that there is a foundation of preconceptions without which the perceptions and inferences of the physicist cannot stand—*preconceptions which are the products of simpler experiences than those yielded by consciously-made experiments.* Passing over the many which do not immediately concern us, I will name only that which does,—the exact quantitative relation between cause and effect. It is taken by the chemist as a truth needing no proof, that if two volumes of hydrogen unite with one volume of oxygen to form a certain quantity of water, four volumes of hydrogen uniting with two volumes of oxygen will form double the quantity of water. If a cubic foot of ice at 32° is liquefied by a specified quantity of heat, it is taken to be unquestionable that three times the quantity of heat will liquefy three cubic feet. And similarly with mechanical forces, the unhesitating assumption is that if one unit of force acting in a given direction produces a certain result, two units will produce twice the result. Every process of measurement in a physical experiment takes this for granted; as we see in one of the simplest of them—the process of weighing. If a measured quantity of metal, gravitating towards the earth, counterbalances a quantity of some other substance, the truth postulated in every act of weighing is, that any multiple of such weight will counterbalance an equi-multiple of such substance. That is to say, each unit of force is assumed to work its equivalent of effect in the direction in which it acts. Now this is nothing else than the assumption which the Second Law of Motion expresses in respect to effects of another kind. "If any force generates a motion, a double force will generate a double motion," &c., &c.; and when carried on to the composition of motions, the law is, similarly, the assertion that any other force, acting in any other direction, will similarly produce in that direction a proportionate motion. So that the law simply asserts the exact equivalence of causes and effects of this particular class, while all physical experiments *assume* this exact equivalence among causes and effects of all classes. Hence, the proposal to prove the laws of motion experimentally, is the proposal to make a wider assumption for the purpose of justifying one of the narrower assumptions included in it.

Reduced to its briefest form the argument is this:—If definite quantitative relations between causes and effects be assumed *à priori*, then, the Second Law of Motion is an immediate corollary. If there are not definite quantitative relations between causes and effects, all the conclusions drawn from physical experiments are invalid. And further, in the absence of this *à priori* assumption of equivalence, the quantified conclusion from any experiment may be denied, and any other quantification of the conclusion asserted. HERBERT SPENCER

MR. SPENCER'S letter in NATURE, vol. ix. p. 420, is likely to give to such of your readers as have not followed the controversy in which he is engaged a false notion of the issues therein. Mr. Spencer writes as though the views of the nature of physical truth that were objected to by Prof. Tait and myself amounted to the ascription of our knowledge of sundry physical laws to organised ancestral instead of individual experiences. In one portion of his reply to me he intimates the same, as, for instance, where he says of me:—

"His argument proceeds throughout on the assumption that I understand *à priori* truths after the ancient manner as truths independent of experience; and he shows this more than tacitly where he 'trusts' that he is attacking one of the last attempts to deduce the laws of nature from our inner consciousness. Manifestly a leading thesis of one of the works he professes to review is entirely unknown to him—the thesis that forms of thought, and consequently those intuitions which those forms of thought involve, result entirely from the effects of experiences organised and inherited" ("Replies to Criticisms," p. 332).

But, in his "First Principles," Mr. Spencer expresses himself far too clearly for him to be able to assign the above as his views at that time on these so-called *à priori* truths. Speaking of the indestructibility of matter, one of the three truths in question, he says:—

"The annihilation of matter is unthinkable for the same reason that the creation of matter is unthinkable—and its indestructibility thus becomes an *à priori* cognition of the highest order—*not one that results from a long continued registry of experiences gradually organised into an irreversible mode of thought;* but one that is given in the form of all experiences whatever."

For the second of the truths he claims a similar authority; while for the third—the Persistence of Force—he claims a yet higher warrant:—

"Deeper than demonstration—deeper even than definite cognition—deep as the very nature of mind is the postulate at which we have arrived (*i.e.* the Persistence of Force). *Its authority transcends all other whatever; for not only is it given in the constitution of our own consciousness,* but it is impossible to imagine a consciousness so constituted as not to give it." ("First Principles," p. 192).

Had Mr. Spencer confined himself to defending such an *à priori* origin of physical truths as he now seems inclined to put forward, I should never have compared his theories to those of the Ptolemaists. But I can leave it with confidence to the readers of NATURE to decide between us as to whether the above passages do not show that at the time when they were written Mr. Spencer understood *à priori*, as there applied, in a manner very like the "ancient manner," and whether he did not maintain that these *à priori* truths were indeed "truths independent of experience."

THE AUTHOR OF THE ARTICLE ON HERBERT SPENCER IN THE BRITISH QUARTERLY REVIEW

[The Editor, very properly wishing, I doubt not, to end the controversy, has sent to me the foregoing letter in proof. My comment on it is very brief.

Had the reviewer read the "Principles of Psychology," placed at the head of his article apparently for form's sake only, he would, not, I think, have made the above rejoinder.

That view of the *à priori* origin of physical truths which the Reviewer now seems to think defensible is the view implied in "First Principles" and the view set forth in the "Principles of Psychology," published years before. Tacitly throughout that work, and explicitly near the end, in a chapter on "Reason," the doctrine is that the "forms of thought" themselves are the products of experience. If the nervous system as a whole and in all its structures has been evolved by converse between the organism and the environment, the fundamental principles of its action, the very "forms of all experiences" have been evolved. Experience itself grew into definiteness gradually. And if the very form of our thought, the very frame-work of our consciousness, has been thus moulded, the inability to conceive a mode of thinking fundamentally different, is simply the result of inability to invert the fundamental action of the structures by which we think.—H. S.]

On the Word "Axiom"

IN reference to the controversy between Mr. Spencer and his reviewer about Sir I. Newton's calling his laws of motion "axioms," it is to be observed that there is a certain ambiguity in the word. "Axiom" is from ἀξιόω (I demand), and would thus signify a first principle to be taken for granted. It does not, of course, carry with it the meaning of a necessary judgment which cannot be contradicted. Whatever may be considered the ground of Euclid's "axioms" so called, Euclid himself did not apply that name to them; but the first nine he called "common notions," and the last three (which are peculiar to geometry) he placed among the postulates (ὁμολογήματα), and heads them with "let it be granted." Now it is clear, from Newton's own words, that in calling his Leges motûs "axioms," he does not imply that they are *necessary* judgments, but that he requires them first of all to be granted (however established) in order to the following reasoning. In other words, they are postulates, like Euclid's last three "axioms." In our modern use of the words "axiom," "axiomatic," there is always implied the *ground* why a proposition is demanded as granted, viz., because its necessity is self evident; but this wider use is not required by etymology, or (I think) in interpreting all ancient writings. F.M.S.

A Beech pierced by a Thorn Plant

THE word *pierced* makes the difference between an impossibility and a fact which is not uncommon in nature. The thorn mentioned in your last impression by Mr. Murphy has grown between two beech stems, which were so close that from their annual increase they grew together, and in so doing they enclosed the thorn, which could no more have *pierced* the beech than it could have pierced a block of marble. If young trees are twisted together they will grow together. Years ago I placed a bar of iron in an interstice between two stems so twisted, in another interstice below it I placed a part of the drag-chain of a waggon. According to Mr. Murphy the two iron appendages "have grown right through the middle of the trunks of the two beeches." They are at least as firmly fixed as if they had done so.

The tree with the iron branches is close to the lodge on Brookwood Hill. Should any of your readers consider it to be worth inspection, the lodge-keeper will show it to them.

April 11 GEORGE GREENWOOD

Mars

I BEG to offer my thanks to Mr. Knobel for his obliging correction (vol. ix. p. 396) with regard to the contrasted tint of the snow-poles of Mars. His observations had quite escaped my recollection.

I have also to mention a correction with which I have been favoured by the Earl of Rosse. It appears that an erroneous hour had been affixed to the drawing of Mars made at Parsonstown on September 14, 1862, and engraved in Mem. R.A.S., vol. xxxii., pl. v., and that an explanation is thus offered of one of the discrepancies commented on by Prof. Kaiser.

Cheltenham, April 9 T. W. WEBB

Bright Shooting-star

A SHOOTING-STAR, equal in apparent brightness to the planet Jupiter, was seen here by me this evening at $9^h 18^m$. It traversed a path of 24° in two seconds, beginning at R.A. 242°, D + 47°, and ending at R.A. 278°, D + 50°. No perceptible train remained after the disappearance of the nucleus, which, however, emitted numerous sparks when in motion. The radiant point of this meteor was probably near β Boötis, and identical with No. 36 in Mr. R. P. Greg's table of radiant positions in the "Monthly Notices R.A.S.," vol. xxxii. p. 350. This is given at R.A. 223°, D + 40° by Greg and Herschel, and at R.A. 224°, D + 38° by Schiaparelli and Zezioli. The meteor described above was not therefore a member of the well-marked meteoric streams of April 18–20. At stations eastward it was probably a much brighter object than observed here, and these brief details may be useful, taken in conjunction with others, in determining its height and velocity.

Cotham Park, Bristol, April 11 WILLIAM F. DENNING

THE LATE DR. LIVINGSTONE

OUR readers are no doubt familiar through the daily press with all that has transpired during the past week in reference to the all-absorbing topic of the late Dr. Livingstone and the home-bringing of his remains. The coffin containing these arrived at Southampton yesterday morning, and was received by the Corporation, Livingstone's family and friends, the President and fellows of the Royal Geographical Society, and many others, with all solemnity and with every mark of genuine respect. The body of the great explorer was accompanied to the station by a long and distinguished procession, and was conveyed in a special train to London, to be buried in Westminster Abbey on Saturday at 1 P.M.

The proposed position of the grave in the Abbey is near that of Major Rennel, the father of English geography, and the friend and adviser of Mungo Park. There was some hesitation between this position and the one near the grave of Sir John Chardin, the Persian traveller.

The President of the French Geographical Society, Vice-Admiral Baron de la Ronciere le Noury, is coming over from Paris, for the express purpose of being present at the funeral.

The Government grants a sum which Sir Bartle Frere "trusts will be sufficient for all purposes." Still we are glad to have Sir Bartle Frere's assurance that in the end there will be "no shortcoming on the part of the Government."

Dr. Livingstone's vocation was not a money-making one; he did not even live to hear that the world ranked him among its greatest men; the end of all his labours was a sad one. This country, all civilised countries we may say, will attend to the appeal which has been made on behalf of his family.

As was to be expected, Scotsmen have taken the initiative in raising a monument to one of the greatest of their fellow-countrymen; at a meeting held at Edinburgh, on Tuesday, it was resolved, in recognition of the "heroic services rendered to science and civilisation by the late Dr. Livingstone," that a national statue be erected to his memory in the capital of his native country. This is right and it is honourable to his fellow-countrymen, though the memory of Livingstone will need no "labour of an age in piled stones" to render it immortal. Indeed a true idea of the full height of his greatness is only as yet beginning to dawn gradually upon us, and it will be some time ere we are able adequately to estimate it. No doubt, therefore, the thought contained in Tennyson's sad strain must have occurred to many a one during the last few weeks—

> "I would that my tongue could utter
> The thoughts that arise in me;"

and perhaps with still greater force those others—

> "Oh for the touch of a vanished hand
> And the sound of a voice that is still."

What honours would we have heaped upon his head had he only lived to reach his native shore!

NATIONAL MUSEUMS IN BRAZIL

THE working of the National Museums in Brazil seems to be conducted on similar principles to those recently advocated for the management of the Government Museums in this country. From a thick volume of 388 pp. explanatory of the topography, constitution, and resources of Brazil, issued in connection with the Brazilian Department of the late Vienna Exhibition, we gather that the most important Natural History Museum in South America, is that at Rio de Janeiro, which was founded in 1817. It is divided into four sections:—the first includes Comparative Anatomy, Physiology, and Zoology; the second Botany, Agriculture, and the Mechanical Arts; the third Mineralogy, Geology, and the Physical Sciences; and the fourth Numismatics, Archæology, &c. Each section has its separate director, who has assistants, and the whole Museum is presided over by a Director-in-Chief. "The Museum has, besides, several corresponding members in the National and Foreign Scientific Societies, and there are two naturalists travelling through the Empire, for the purpose of making collections.

"The principal object of the National Museum is, to collect and study all the natural products of the country, and to deliver public lectures on the science of its province, spreading among the people theoretical and practical knowledge, in a simple style, adapted to their comprehension.

"The Museum," it is stated, "now keeps up a correspondence with European establishments of the same description, and willingly exchanges duplicates of its collections for those of foreign museums.

"The Government intends to create in the provinces several museums independent of that in the capital of the empire, that they may exchange among one another the respective products of each one, receiving at the same time from the central one, not only the necessary instructions for the classification and study of the collections, but its superabundant duplicates."

POLARISATION OF LIGHT*

VII.

AMONG the phenomena of polarised light which may be observed either with a Nicol's prism or even with the naked eye, one of the most curious, and perhaps not yet fully explained, is that of Haidinger's brushes. If the eye receives a beam of polarised light a pale yellow patch in the form of an hour-glass, the axis of which is perpendicular to the plane of vibration, is perceived. On either side of the neck of the figure two protuberances of a violet tint are also seen to extend. After a little practice these figures or "brushes" may readily be observed. If the day be cloudy a Nicol must be used and directed to a tolerably bright cloud. The brushes are better defined in one position than in others; but if the Nicol be turned round, the brushes will be seen to revolve with it. If on a clear day we look in a direction at 90° from that of the sun, where the skylight is most completely polarised, the brushes may be seen with a naked eye. Jamin has suggested in explanation of this phenomena that the substances of the eye act like a pile of glass plates, or rather spheres, which affect in different degrees (1) the rays of the same colour whose vibrations are differently inclined to the plane of incidence, and (2) the rays of different colours whose vibrations are similarly inclined. This will cause one colour to predominate in a general direction parallel, and its complementary to predominate in a plane perpendicular, to that of vibration. Helmholtz, however, connects the phenomenon with some double refraction due to the yellow spot in the eye, with the area of which that of the brushes is coincident.

It was explained above that in Iceland spar there is a particular direction, viz. that of the line joining the two opposite obtuse angles of the natural crystal, in which there is no double refraction, and in which all rays travel with the same velocity. This direction (that is to say, this line and all lines parallel to it) bears the name of the optic axis. There are many other crystals having the same property in one and only one direction, in other words having a single optic axis. There is, moreover, another class of crystals having two such axes. Crystals of the first class or uni-axal crystals are again divided into two groups, viz. positive, in which the extraordinary ray is more refracted than the ordinary, and negative, in which the ordinary ray is the more refracted. It will be remembered that the ray which travels slowest is the most refracted. Among the former may be mentioned

UNI-AXAL CRYSTALS.

Positive.

Apophyllite.	Stannite.
Boracite.	Superacetate of copper and lime.
Ditopaz.	
Hydrate of magnesia.	Sulphate of potash and iron.
Hyposulphate of lead.	
Ice.	Tungstate of zinc.
Quartz.	Zircon.
Red Silver.	

Negative.

Apatite.	Honey stone.
Arseniate of copper.	Idocrase.
Arseniate of lead.	Mellite.
Arseniate of potash.	Mica.
Beryl.	Molybdate of lead.
Carbonate of lime and magnesia.	Nepheline.
	Octaedrite.
Carbonate of lime and iron.	Phosphate of lime.
Chloride of calcium.	Phosphate of lead.
Chloride of strontium.	Rubellite.
Cinnabar.	Ruby.
Corundum.	Sapphire.
Emerald.	

* Continued from p. 386.

Crystals are usually divided into six systems, in each of which there is a fundamental aad a variety of derived forms. The fundamental form of each system is based upon the number, magnitude, and inclination of the crystallographic axes or lines drawn through a point in the interior of the crystal, and terminating in its angles. The optic axes do not of necessity coincide with any of these.

(1.) The regular system, which is based upon a system of three equal rectangular axes. Any form derived from this will be perfectly symmetrical with reference to the three axes, and will present no distinguishing feature in relation to any of them. Crystals belonging to this system have no optic axis, nor any doubly refracting property.

(2.) The quadratic system, based upon a system of three rectangular axes, whereof two are equal, but the third greater or less than the other two. Crystals belonging to this system have one optic axis coinciding with the last-mentioned crystallographic axis.

(3.) The hexagonal system, having three equal axes lying in one plane inclined at 60° to one another, and a fourth axis at right angles to the other three. Crystals of this system have one optic axis coinciding with the fourth crystallographic axis. Iceland spar belongs to one of the derived forms of this system.

(4.) The rhombic system, having three rectangular but unequal axes.

(5.) The monoclinic system, which differs from the rhombic in this, that one of the three axes is oblique to the other two, which are still rectangular to one another.

(6.) The triclinic system in which all the axes are oblique.

All crystals belonging to the last three systems have two optic axes. In the rhombic system they lie in a plane containing two of the three crystallographic axes; in the monoclinic, they lie either in the plane containing the oblique axes, or in a plane at right angles thereto. In the triclinic no assignable relation between the optic and the crystallographic axes has been determined.

The phenomena of colours and their variations hitherto described have been produced by a beam of light, all the rays of which were parallel in their passage through the crystal or other substance under examination. There is, however, another class of phenomena due to the transmission of a convergent or divergent beam of polarised light, which we now proceed to consider.

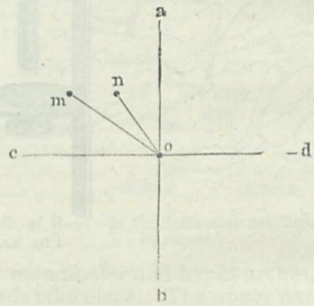
It was shown above that the retardation due to any doubly refracting crystal, and consequently the colour produced by it is dependent on the thickness; and that with a crystal of constantly increasing thickness, the colours go through a complete cycle, and then begin again. Suppose then a divergent beam to fall perpendicularly upon a uni-axal crystal plate cut at right angles to the optic axis; the central rays will fall perpendicularly to the surface; but the rays which form conical shells about that central ray will fall obliquely. The rays forming each shell will fall with the same degree of obliquity on different sides of the central ray, those forming the outer shells having greater obliquity than the inner. Now the more obliquely any ray falls upon the surface the greater will be the thickness of the crystal which it traverses; and this will still be the case even though it suffers refraction, or bending towards the perpendicular on entering the crystal. Each incident cone of rays will consequently still form a cone when refracted within the crystal, although less divergent than at incidence, in its passage through the plate; and the successive refracted cones will be more and more oblique, as were the incident cones, but in a less degree, as we pass from the more central to the more external members of the assemblage forming the beam of light.

Let A B C D (Fig. 21) represent the crystal plate, O P the direction of the optic axis and of the central ray, O n, O n′ those of any two other rays. The ray O P will not be divided; but O n will be separated by the double refraction of the plate into two, n s, n r, the one ordinary, the other extraordinary; and these will emerge parallel to one another, and may be represented by the lines s t, r v. Similarly the effect of double refraction on O n′ may be represented by n′ s′, n′ r′, s′ t′, r′ v′. Suppose now that the process were reversed, and that two monochromatic rays, one ordinary, the other extraordinary, reach the plate at s and r in the directions t s, v r, respectively; these would meet at n and travel together to O. Suppose, further, that the difference in length of s n and r n is equal to one wave-length, then, since one of them is an ordinary and the other an extraordinary ray, their vibrations will be perpendicular to one another, and if the polariser and analyser be crossed, the point n viewed from O will appear dark. Similarly, if two rays arrive in the directions t′ s′, v′ r′, at the points s′ r′ respectively, they will meet at n′ and proceed together to O; and if the difference of the paths s′ n′, r′ n′ be two wave-lengths, the point n′ will also appear dark. A pair of rays reaching the crystal at points between the pairs before-mentioned, will emerge at a point n″ between n and n′, and will present a difference of phase equal to a half wave-length. On principles explained in an earlier part of these lectures, such a point n″ will appear bright. On either side of n″, that is towards n and n′, the light will gradually fade. The same alternations of light and darkness will recur at intervals as we proceed along any straight line drawn outwards from the central ray. And inasmuch as the obliquity of the ray is the same for every point equidistant from the centre O, it follows that the phenomena of light and darkness will be the same throughout each circle drawn about the centre O. In other words, the centre will be surrounded by rings alternately bright and dark. The diameters of the ring depend, as was seen above, on the wave-length of the particular light used, and will consequently be different for different coloured rays. If, therefore, white light be used, the different coloured rings would not coincide, but would be disposed in recurring series as we proceed outwards from the centre.

Another effect would, however, also be produced. Suppose the polariser and analyser to be so placed that, the field being regarded as a map, the vibrations in the one being E. and W., those in the other N. and S.; then of the two rays emerging at the most northern or the most southern point of any ring the vibrations of one would be towards the axis, or N. and S.; those of the other would be across it, or E. and W. And of these one would be extinguished by the polariser, the other by the analyser; and the same will be the case for every ring. Hence, throughout a N. and S. line crossing the entire field the light will be extinguished; and a similar effect will obviously occur along an E and a W. line. Hence, when the polariser and analyser are crossed, the entire system of rings will be intersected by a black cross, two of whose arms are parallel to the plane of vibration of the polariser and two to that of the analyser, and the rings in the quadrants on each side of an arm are of complementary tints. When the analyser is turned round through a right angle from its former position, only one set of vibrations (say those executed in a direction E. and W.) will be extinguished, and consequently along one pair of arms of the cross the ordinary rays will pass undisturbed, along the other the extraordinary; that is to say, the cross will be white. When the polariser and analyser occupy any other position than those noticed above, there are two crosses inclined at an angle equal to that between the planes of vibration, each arm of which separates complementary rings.

Various forms of polariscopes have been devised for showing the crystal rings. The simplest of these is the tourmalin forceps, which consists of two plates of tourmalin fixed in cork discs; the latter are encircled in wire in such a way that they may be turned round in their own planes. The wire after encircling one disc is bent round so as to form a handle; it then encircles the other; and the elasticity of the wire allows the pair of discs to be opened and shut like a pair of pincers. If a crystal plate be inserted between the two, and the whole held close to the eye, the rays from parts of the field at different distances from the centre will reach the eye, having traversed the crystal with different degrees of obliquity; and a system of rings and brushes will be formed.

Another method consists in applying to Norremberg's polariscope a pair of lenses, one below the crystal with the crystal in the focus, the other above it. The first ensures that the rays shall traverse the crystal with different degrees of obliquity; the second brings within the range of vision rays which would otherwise fail to reach the eye, and at the same time converging them into a cone with a smaller vertical range, renders the ring smaller than when seen with the simple tourmalins. An additional lens of greater focal length, *i.e.* of less power, is



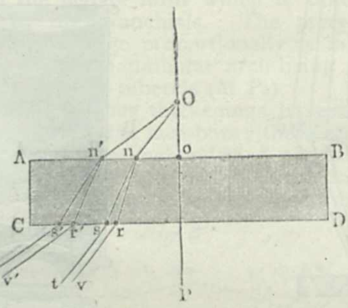


FIG. 21.

often added in order to adjust the whole to individual eyesight.

Fig. 22 gives the general appearance of the addition to the apparatus of Norremberg described above, and Fig. 23 the course of a system of rays brought to a focus on the lens a b, and again converged by a second lens c d.

But by far the most successful arrangement for enlarging the field of view so as to comprise the complete system of rings even with bi-axal crystals having widely inclined optic axes, is the system of lenses due in the first instance to Norremberg. The disposition of the parts is shown in Fig. 24; and the general appearance of the instrument as constructed by Hofmann of Paris, and called by him the "Polarimicroscope," is also given, Fig. 25. In this instrument the lenses which converge the rays upon the crystal plate can be taken out, and replaced by others giving parallel light; it can then be used as an ordinary polariscope.

Mention has been made above of the effect of the circular polarisation of quartz in the colours produced by a beam of parallel rays of polarised light. It remains for us to examine the modification which the rings and brushes undergo from the same cause. It has been explained that a ray of plane-polarised light in traversing a crystal of quartz in the direction of its axis is divided into two, the vibrations of which are circular, one right-handed, the other left. If the ray traverses the crystal in a direction perpendicular to the axis, and if the original vibrations are neither parallel nor perpendicular to the axis it is also divided into two, whereof the vibrations are not circular but rectilinear. It was suggested, first by Sir G. Airy, that these circular and rectilinear vibrations are limiting cases of elliptical; and both theory and experiment tend to confirm the suggestion, by showing that if the ray be incident on the crystal in any direction

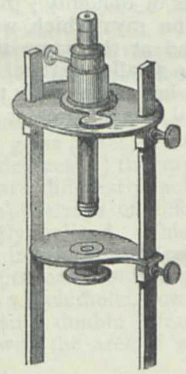
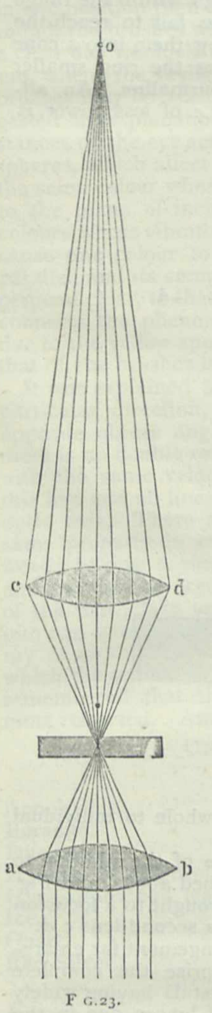


FIG. 22.



F G.23.

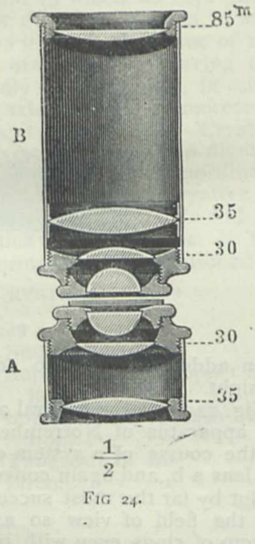


FIG 24.

oblique to the axis, it is divided into two, the vibrations of which are similar ellipses having the longer diameter of the disc coincident with the shorter of the other, and the motion in the two oppositely directed. The longer diameters of the ellipses coincide with the directions of vibration of the ordinary and extraordinary rays in the case of an ordinary positives crystal; and are consequently directed, the one toward the centre of the figure, the other in a direction at right angles to the first.

The exact, or even appproximate determination of the figures produced is a complicated question, and requires mathematical analysis for its solution, but a general idea of their nature may nevertheless be easily formed. When the polariser and analyser are either parallel or crossed, circular rings are formed, and towards the outer parts of the field traces of the black cross are seen, which grow stronger as we proceed outwards from the centre, that is, towards the parts where the rays are more oblique, and where the polarisation more nearly approaches to rectilinear. But in the centre, and near to it, where the polarisation is circular, or nearly so, the effects will resemble those produced by parallel rays, viz. the rays of different colours will emerge plane-polarised in different planes, and will be variously affected by the angle between polariser and analyser. In no position can they all be extinguished, and consequently in the centre all traces of the black cross will disappear.

When the planes of vibration of the polariser and the analyser are inclined at any other angle than 0° or 90°, the arms of the cross are less strongly marked, and the curvature of the rings becomes less uniform, increasing in the four points where they are crossed by the arms, and diminishing in the intermediate quadrants. When the angle between the planes of vibration is 45°, the rings assume a nearly square form, the corners of the square lying upon the lines which bisect internally and externally the angles between the planes. If the figures are produced

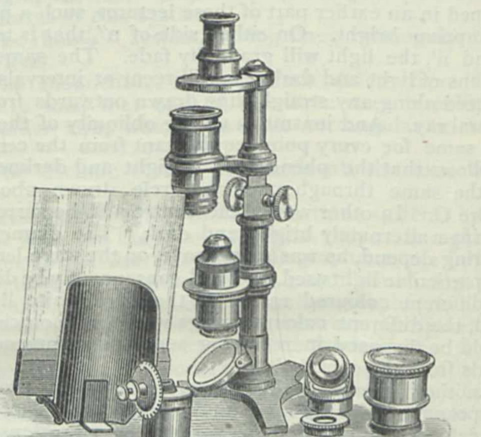


FIG. 25.

with the analyser at 45° by two quartz plates of equal thicknesses, one right-handed, the other left, it will be found that the diagonals of the squares are at right angles to one another, the remains of the black cross occupying the same position in the field in both cases.

If two plates of the same thickness, the one right-handed and the other left, are placed one over the other, a beautiful effect, called from their discoverer Airy's spirals, is produced. In the centre of the field the rotatory powers of the plates neutralise one another, and a black cross commences. As we proceed outwards, the arms of the cross cease to be black, and become tinged with red on one side, and with blue on the other. At the same time they are bent round in a spiral form, in the direction of the hands of a watch if the first plate be right-handed, and in the opposite direction if the first plate be left-handed. These spirals intersect at intervals the circular rings; the points of intersection lie in four rectangular directions, which terminate towards the outer margin of the field in four arms of a shadowy cross. The colours of the rings and spirals are more brilliant and better defined than in most other phenomena of chromatic polarisation.

W. SPOTTISWOODE

(*To be continued.*)

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL"*

II.

IT is well known that the eggs of sharks and rays, when deposited, are enclosed in a strong horny capsule or "purse" formed as a secretion from the oviduct. In both groups these curious appendages have the form of a pillow-case, the corners being pointed in the rays, and produced into long tendril-like processes in the shark and dog-fish. The embryo remains enclosed in the purse until about six months after oviposition, and it is during this period that all the most important metamorphoses are gone through.

The youngest embryo described was nearly an inch

Fig.3

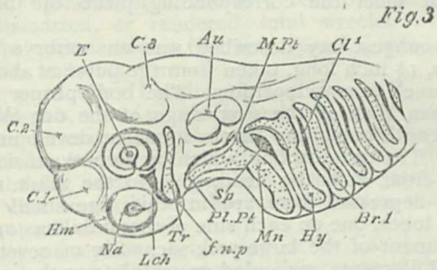


FIG. 3.—Head of Embryo Dog-fish, 11 lines long. Lch, lachrymal cleft; C 1, 2, 3, Cerebral vesicles; Hm, Cerebral hemispheres; fnp, fronto-nasal process; Sp, Spiracle. Other references as before. The visceral arches are dotted for distinction's sake.

long, an extremely active little creature, attached to a yolk-sac about $\frac{3}{4}$ of an inch in diameter. In this stage the head and branchial region are large and conspicuous, the body slender, and tapering off to a long thread-like tail. The dorsal laminæ have completely united, leaving, however, a very thin covering to the hinder division of the brain, which consists of the three primary cerebral vesicles (Fig. 3, C 1—3), bent over the end of the notochord in such a way that the second, or middle division, forms the anterior termination of the head; the "cerebral flexure" is, therefore, complete. The future hemispheres (Hm) have already appeared as small buds from the fore-

Fig.4

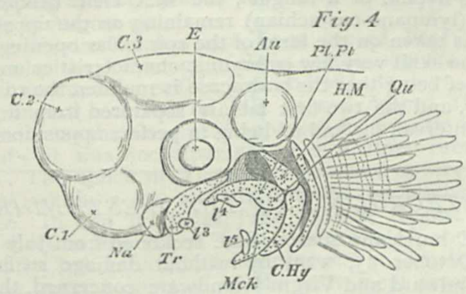


FIG. 4.—Head of Embryo Dog-fish, $1\frac{1}{8}$ in. long. References as before.

brain (C 1). The nasal, visual, and auditory organs are in an extremely rudimentary condition. On the under surface of the head is the large square mouth, bounded above by the fronto-nasal process (fnp), a shield-shaped elevation of the integument between the nasal sacs, found in the embryos of even the highest vertebrata, but persistent in the sharks and rays. Beneath the eye, and communicating by a slit running below the inferior boundary of the fronto-nasal process, is a cleft (Lch) answering to the lachrymal passage of the higher vertebrata, and formed by the shutting off of a portion of the original first visceral cleft by the growth of the pterygo-palatine arcade. This cleft, persistent in the higher animals, is a transient structure in the Elamobanchs. One of the most noticeable features in the embryo at this stage is the presence of a number of long filamentous external gills, each containing a single capillary loop; of these about ten spring from the hyoid and each of the branchial arches, while four much shorter ones project from the future spiracle, and are attached to the mandibular arch. The internal branchiæ are at present functionless, and form mere cog-like projections on the arches.

The embryo at this age is so transparent, that the visceral arches can be seen with sufficient distinctness through the skin without any dissection whatever. Even at such an early period, the anterior face-bars already begin to show signs of segmentation, there being constric-

Fig. 5.

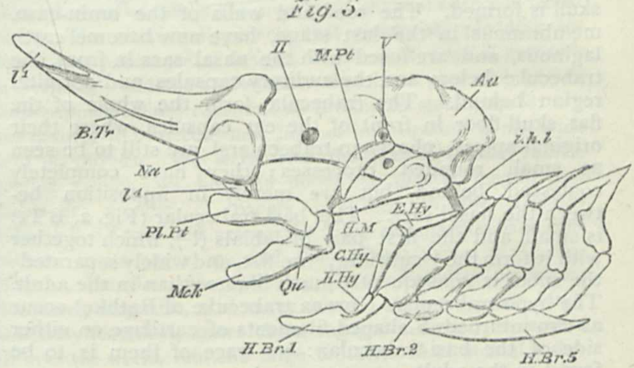


FIG. 5.—Skull of Ray. M Pt, Spiracular cartilage; ihl, inter-hyal ligament.

tions in the mandibular and hyoid arches, where division will afterwards take place. The upper part of these arches has assumed the pedate form which is taken on at a later period by the branchials. The pterygo-palatine arcade is already as large proportionally as in the adult, the true apex of the mandibular arch being reduced by its outgrowth to a mere tubercle (M Pt).

Granular subcutaneous thickenings have already appeared in relation with the face-bars; these are the extra-viscerals. In the same unchondrified condition are the parachordal and paraneural elements of the skull.

Embryos of $1\frac{1}{8}$ and $1\frac{1}{2}$ in. in length possess external gills

Fig.6

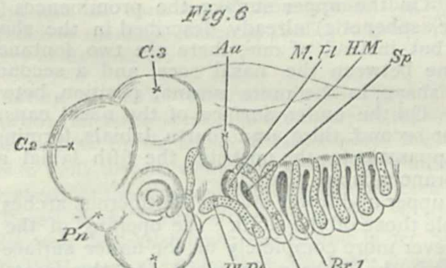


FIG. 6.—Head of Embryo Ray, $1\frac{1}{2}$ in long. Pn, Pineal gland.

two or three times as long as in the preceding stage those on the mandibular arch having already shrunk and begun to form the pseudo-branchia; the internal gills are still functionless. The eye is completely formed. The investing mass and the nose and ear capsules are chrondified, but the two halves of the former are still separate, and the roof and walls of the cranium membranous. To make out clearly the relations of the facial arches, it is now necessary to dissect away the skin (see Fig. 4); it is then seen that the process of segmentation has advanced greatly, the arches behind the mouth being split up as in the adult, and differing from those of the full-grown shark only in form. The trabeculæ have become flat-

* Continued from p. 426.

tened out from above downwards, but are still separate, and the lower-jaw arch, besides being divided into paleto-quadrate and Meckel's cartilage, has approached still more nearly to the adult character by the conversion into fibrous tissue of its apex (Figs. 2 and 3, M Pt).

The third stage described was a ripe embryo, about two inches long, having nearly the form of the adult. In this condition the external gills have entirely disappeared, the internal gills now performing the whole function of respiration. The skull has assumed all the characters of the adult, except as regards a few minor details, chondrification and segmentation being perfect. The investing mass has not only completely enclosed the notochord, but has formed an arch, like that of a vertebra, over the hinder part of the brain: in this way the occipital region of the skull is formed. The roof and walls of the brain-case, membranous in the last stage, have now become cartilaginous, and are fused with the nasal sacs in front, the trabeculæ below, and the auditory capsules and occipital region behind. The trabeculæ form the whole of the flat skull-floor in front of the ear capsules, where their original apices (pharyngo-trabeculars) are still to be seen as small rounded processes; they have completely coalesced behind, but are merely in apposition between the nasal sacs. The basi-trabecular (Fig. 2, B Tr) is small, and the first pair of labials (l^1), which together with it form the "cutwater," are flat, and widely separated; the snout is consequently much blunter than in the adult. The hypo-trabeculars (cornua trabeculæ of Rathke) occur as two inturned S-shaped filaments of cartilage on either side of the basi-trabecular: no trace of them is to be found in the adult.

III.—*Skull of the Ray or Thornback* (Raia clavata).—On the whole the skull of the ray resembles very closely that of the shark; in some respects, however, it approaches more nearly to the higher fishes, and in others, again, retains a lower or more embryonic character.

One of the chief points of difference between this type and the preceding is the much greater elongation of the skull, chiefly owing to the immense development of the basi-trabecular (Fig. 5, B Tr), which is produced to form the long, stout rostrum, the apex of which is strengthened by the first pair of labial cartilages (l^1). The region between the orbits is much pinched in, while the nasal and auditory regions are extremely broad, the nose capsules, especially, being as far apart as in the embryo shark. On the upper surface, the prominences (epiotic, pterotic, sphenotic) already described in the shark, are seen; but instead of one, there are two fontanelles, an oval one between the nasal sacs, and a second of an oblong shape, in the more normal position, between the orbits. On the under surface of the nasal capsules are seen the second, third, and fourth labials, forming a valvular apparatus for the nostrils; the fifth labial and the extra-branchials are absent.

The upper and lower jaws or dentigerous arches closely resemble those of the shark; the opening of the mouth is, however more completely on the under surface of the head, as in the embryo Squaloid. In the front wall of the spiracle a semi-lunar cartilage (M Pt) is found, connected by ligament with the auditory capsule above, and with the angle of the lower jaw below, and having the same relations to the fifth and seventh nerves as the meta-pterygoid ligament of the shark (Fig. 2, M Pt), or the bone of the same name in the osseous fish; this, therefore, is the true apex of the mandibular or first post-oral arch.

There is no mistaking the hyo-mandibular (H M) a cartilage having precisely the same connection and relation to the hinder division of the *portio dura* as the part similarly named in the shark, but much more slender, pointed below, and inclined forwards. The remainder of the hyoid arch, however, has taken on an entirely new character, and shows a marked advance towards the Teleostian type, being attached, not to the lower part of the hyo-mandibular, but to its upper posterior angle, by means of a band of ligamentous fibre, answering to the small styliform bone (stylo-hyal of Cuvier) which in the osseous fish connects the free portion of the hyoid with the suspensory apparatus. The gill-bearing part of the hyoid is slenderer than in the shark, and more highly segmented, being divisible into epi- cerato-, and hypo-hyals (E Hy, C Hy, H Hy); the basi-hyal or keystone-piece is absent.

The branchial arches differ from those of the shark chiefly in the great development of the inferior segment or hypo-branchial. The first of these (H Br. 1) is much extended, and, uniting with its fellow of the opposite side, forms a transverse bar behind Meckel's cartilage. The second, third, and fourth hypo-branchials are broad adze-shaped plates, while the fifth is coalesced with its fellow in its hinder half, and extended forwards, so as nearly to meet the corresponding piece of the first arch.

The youngest ray described was an embryo of *R. maculata*, $1\frac{1}{3}$ inch long, taken from the purse at about the seventh week from oviposition. The body proper is not larger than that of the first stage of the dog-fish, the greater length being due to the immense development of the tail. The pectoral fins, which by their expansion and union in front with the head, give to the adult ray its peculiar depressed form, are at this age small semi-elliptical lobes, one on each side of the umbilicus or point of attachment of the large yolk-sac. Six or seven long branchial filaments, expanded or spatulate at the end, are attached to the hyoid and branchial arches, but none are apparent externally on the mandibular.

The facial arches are visible in a side view with perfect distinctness, and have already advanced considerably in segmentation, the apex of the mandibular being on the point of separation so as to form the spiracular cartilage, and the proximal end of the hyoid being cleft vertically, thus separating the hyo-mandibular from the epi-hyal.

Three months after oviposition, although the yolk-sac is still as large as a small walnut, the embryo has completely taken on the adult form, the pectoral fins having enlarged greatly, and brought the gill-slits to the ventral surface; from these the external branchiæ still project, being now in the form of long threads, almost like the hyphæ of a fungus; the first cleft behind the mouth (tympano-eustachian) remaining on the upper surface has taken on the form of the spiracular opening.

In the skull very few embryonic characteristics are left, the chief being that the brain-case is rounder, the rostrum shorter, and the two first labials separated from it by a slight interval, instead of being in perfect apposition.

METEOROLOGY OF THE WEST INDIES

THE hurricane season, here reckoned from July 25 to October 25, went by without damage so far as the Windward and Virgin Islands are concerned, though not without disastrous examples of the phenomenon from which it derives its name elsewhere. Two cyclones of the ordinary kind have in fact visited these seas during the above period; and although neither of them included the island of St. Thomas in its range, yet they passed sufficiently near to make us aware of their existence, and to create considerable alarm among the inhabitants.

The first of these appears to have originated about lat. 10° N. long. 55° W., on or near August 10. Taking a north-westerly direction it passed parallel with, but at a considerable distance from the Windward islands, where from August 11 to 13 the weather showed signs of great disturbance with violent squalls, that shifted to every part of the compass; while at Martinique in particular, where the most threatening signs appeared, the mercurial barometer sank to 29·60. On the 14th similar indications showed themselves at St. Thomas—rain, squalls, and thunder; while on the night of the 15th the barometer suddenly fell to 29·70, and a violent gust of wind from the north caused many of the natives to barricade their windows in anticipation of the worst. This state of things lasted till next day at noon, when the mercury rose and the sky cleared.

But by this time the cyclone, now only about a hundred miles to the east of the islands, had fully formed itself; and henceforth its course was only too clearly marked by the damage it caused among the shipping. From August 17 to 24 it passed north, with a westerly inclination, till it fell in with the course of the Gulf Stream, above Florida, and then followed that line, but gradually nearing the coast, up to Nova Scotia, where the ravage was tremendous, upwards of a hundred vessels having been either dismasted, or rendered total wrecks. Further north the cyclone seems to have expanded into an ordinary storm and disappeared.

These particulars I gathered from the captains of the injured vessels, some of which took refuge in this port. They are illiterate men, and not capable of furnishing exact details; but all agreed in describing the wind-current as having been from north to south by west, and so back by east to north; the lowest barometric indication I heard speak of was 29°.

The second cyclone originated in the Carribæan Sea itself, to the west of Barbadoes. Telegrams of threatening weather dated September 25 reached us at St. Thomas; and on the 26th the aspect of matters here was gloomy; the sky murky, especially to the south, with continued flashes of lightning, and a very heavy sea. But the hurricane did not touch Santa Cruz; its first long-shore visit having been made on the 28th at Haiti, where several small ships were lost, and much mischief done. Jamaica escaped; but on the 30th the whole southern coast of Cuba was ravaged from east to west, and many lives lost by sea and shore. From Cuba the cyclone continued to pass west till it reached the Mexican coast, which it skirted, then turned east, touching Havanna on October 4, Florida on the 7th, and then, following the Gulf Stream, was lost in mid-ocean. Its greatest fury was in the Gulf of Mexico itself, where the injury done to the shipping almost equalled that caused off Halifax by the gale of August 24.

Some disquietude has also been caused here at St. Thomas by the frequency of slight earthquake shocks, of which I counted five within a period of forty days. The two strongest occurred on July 22 and August 12; in both instances the movement appeared to pass from east to west; it was accompanied by a distinct rumbling sound. The shock of August 12 occurred at 8.15 P.M., and was within a few seconds followed by another, but slighter. In two instances, June 16 and August 27, a slight shock at this island had been preceded, about an hour and a half before, by a stronger one at Jamaica: so that the general direction of the movement must have been contrary to the apparent surface vibration from west to east.

I may add that the whole of this island is manifestly undergoing a gradual upheaval, as appears by the wave-worn rocks of recent date, but already two or three feet above water mark; sea-shells and corals left dry, and similar indications. Hence the artificial channel opened, for purposes of cleansing by means of the current thus established, between the south-western extremity of the harbour and the outer sea, and which is in itself a clean cut, twenty feet wide, through a narrow band of rock, has, since 1870, when it first was made, lost so much of its depth as scarcely to allow of boat-passage; and threatens at no distant period to become absolutely useless.

W. G. PALGRAVE

NOTES

THE well-known German serial, Poggendorff's *Annalen der Physik und Chemie* has now been in existence fifty years, and we are glad to see that practical recognition has just been taken of the striking fact that it has, during this long period, been under the sole editorial direction of Prof. Poggendorff, while printed and published by the same house in Leipzic. It was agreed, a short time since, by a number of friends of the learned professor, that they should relieve him of his editorial duties for one volume, and that this should be presented to him in honour of the occasion, as a "Jubelband," or Jubilee volume. The importance of the work done by M. Poggendorff and his *collaborateurs*, during half a century, through the *Annalen*, is sufficiently obvious to any who have taken an interest in the progress of physical science in recent years. The serial well reflects that enterprise, plodding industry, and philosophical insight, which mark original research in Germany; and the 156 volumes that have appeared (six of these supplementary) constitute an invaluable storehouse for any one desiring to prosecute new lines of investigation in the wide field of physics. We learn from the preface to the Jubilee volume (which we hope to notice at greater length) that the entire number of papers published in the *Annalen* hitherto is 8,850; and among the 2,167 authors who have contributed to its pages, we find the eminent names of Liebig, Magnus, Berzelius, Rammelsberg, Rose, Faraday, Brewster, Becquerel, Regnault, and many others. A work of this kind, as is truly remarked, unites those engaged in similar researches all over the world, into one large brotherhood of mutual assistance and regard. We congratulate the learned editor on the completion of such a long term of arduous and honourable service to Science, and heartily join in the wish that this Jubilee volume may be followed by many others edited by the "Jubilar" himself.

WE are given to understand that preliminary negotiations are on foot for the establishment of a central establishment for Ocean Meteorology in Germany. We may hope that when such a step is in contemplation, the work done by Herr von Freeden, who has for the last seven years conducted the Norddeutsche, lately called the Deutsche Seewarte, at Hamburg, will meet with its full measure of recognition. The establishment in question has been maintained at the sole expense of the town of Hamburg, and has risen steadily from a small beginning to its present state of thorough efficiency, thanks, in great measure, to the energy of its director.

IN the review of Belt's "Naturalist in Nicaragua" by Mr. Wallace, p. 221, reference is made to the theory of the origin of cyclones propounded by the author in terms which might lead our readers to think that his views have been entirely unnoticed. Such is however not the case, and our attention has been drawn to Prof. Reye's work "Die Wirbelstürme, &c., in der Erd-Atmosphäre, mit Berücksichtigung der Stürme in der Sonnen-Atmosphäre" (Hanover 1872), in which Mr. Belt's views are discussed at some length, with an expression of regret that so little attention has been attracted to them.

THE Turners' Company of the City of London have acknowledged the debt which their Art owes to pure scientific research, by presenting the freedom and livery of that Company to Dr. John Phillips, F.R.S., Professor of Geology in the University of Oxford, in recognition of his introduction into architecture of the various materials which constitute the rocks of England. Mr. John Jones, a member of the livery, said the City of London was always willing to bestow its honours on successful generals, conspicuous statesmen, and devoted patriots—and the tributes were honourable to both sides—but that was the very first occasion on which they had offered the like distinction to a patient, observant, and reflecting student of nature. In doing so they, at the same time, offered their thanks to the University of Oxford for having included physical science in its curriculum of education, and they celebrated, so to speak, the alliance in that city of art and science.

THE recent appearance of a French translation of the last edition of Prof. Haeckel's world-known "Natürliche Schöpfungs-Geschichte;" or, "History of the Creation of Organised Beings," will give a larger number of students the opportunity of mastering its valuable contents. How is it that no translation has yet appeared in our own language?

MEN of Science will be glad to learn that the Premier has recommended to the Queen for a pension of 100*l*. on the Civil List Mrs. C. L. Basevi, the mother of Captain Basevi, who lost his life on the Thibet frontier of India, whilst engaged in exploring the mountain passes, and pursuing other scientific inquiries.

DR. JOHN ANDERSON, Director of the India Museum of Calcutta, is at present in this country on two years' leave of absence. He is, however, devoting his holiday to working out the results of the Yunan Expedition, to which he was attached as naturalist three years ago. The Linnean Society has undertaken their publication, which will embrace a full description of the anatomy of the fresh-watar Dolphin of the Ganges (*Platanista gangetica*), as also of the still rarer fresh-water Cetacean of the Irawady *Orcella flumenalis*.

ON Friday, April 10, M. Leverrier gave a *soirée* at the National Observatory of Paris, in honour of the delegates of the French Scientific Societies. The weather was unfavourable, but the exhibition of scientific instruments was very successful indeed. Many new electrical apparatus were exhibited for the first time. No gaslight was used; an electrical lamp by Perrin being the only lighting medium. A lecture was delivered by M. Wolf, on phenomena of polarisation, illustrated by optical experiments by Dubosc.

THE Commissioners for the Construction of a Universal Metre are at present superintending the fabrication of the definitive standards, which will be distributed amongst the several Government delegates to the International Congress. The operations are executed at Paris, in the laboratory of the School of Mines.

M. ALLUARD, the originator and director of the Puy de Dome Observatory, has announced that an inauguration will take place next September. Invitations will be sent to England as well as throughout France. The cost of the building will be something more than 4,000*l*., and the work is fast advancing. The Puy de Dome Observatory will be connected by an electric telegraph with another observatory built at Clermont, and which is already in operation; the difference of level between the two stations will be more than 4,000 ft. When excavating on the top of the mountain it was discovered that a large building about 80 yards in breadth had existed on the spot. It is supposed to have been a Roman fortress and temple; a number of Roman medals were discovered.

M. COLLADON, the Geneva physicist, has published an essay on the subject of turning poplars into lightning conductors. He proposes to insert in the lower part of the trunk a metallic rod, which he connects with the earth by a chain, so that the fluid cannot leave the tree to dart at any object placed within a short distance, which at present is very often the case.

M. SAINTE-CLAIRE DEVILLE, appears to have been again successful in his weather predictions. We shall give details in our next on the important question.

FRENCH officials are organising a fusion between the postal and telegraphic officials.

A REMARKABLE instance of the rapid spread of a new pest is furnished by the history of *Puccinia Malvacearum*, a fungus parasitic on various plants belonging to the natural order Malvaceæ. Its native country is probably Chili, where it was discovered by Bertero on *Althæa officinalis*. Its first appearance in Europe was in April 1873, on *Malva sylvestris*, in the neighbourhood of Bordeaux, and in August it had extended to several other plants of the same order in the botanic gardens of that town, but, singularly enough, was not found on *Althæa officinalis*, several other nearly allied genera being also exempt from its attacks. In Germany it was first discovered in October, while in this country it was detected in the summer of 1873, nearly simultaneously in many widely-dispersed localities, as Exeter, Salisbury, Chichester, Shere in Surrey, the neighbourhood of London, Eastbourne, Pevensey, Sandown in the Isle of Wight, and Lynn, and threatens to be exceedingly destructive to the hollyhocks.

TWO remarkable instances of protective mimicry have lately been described by Prof. Gerstaecker, both among parasitic Hymenoptera, and having apparently for their object to facilitate the access of the parasite to the nest of the host for the purpose of laying its eggs. *Crypturus argiolus* differs altogether in colour and marking from the allied species of Ichneumonidæ, and assumes even in the minutest details those of the wasp *Pollistes gallica*, on which it is parasitic. To so great an extent is the mimicry carried out that even variations characteristic of particular districts are reproduced, the area of distribution of both insects being very wide. In the second case it is the colour and markings of a wasp, *Vespa germanica*, that are imitated by its parasite *Conops diadematus*.

AT the east end of the Palm House at Kew there is a fine specimen of the rare *Agave univittata* coming into flower. Near it stand the still stately flowering stems of two allied plants, *Agave jacquiniana* and *Fourcroya gigantea*.

THE French conscription enables us to study annually the composition of the growing generation. Last year from about 300,000 young men passing the examination for recruiting the army, 16,000 were discharged on account of having lost their brothers or having had them wounded in the war, 11,400 as being sons or grandsons of widows, or of people above seventy years of age, 1,600 elder brothers of orphans, 16,000 as not being strong enough, 10,000 for lameness, 8,000 not tall enough, 4,000 from having defects of the bowels, 3,000 of the eyes, 2,700 organs of generation, 2,000 bad teeth, 1,000 as being mute, &c., 1,200 epileptics, 600 deaf, 80 blind, 1,000 phthisic, &c.; in all, 89,000 were left out of the contingent.

IN the report furnished us by the Secretary of the Anthropological Institute (vol. ix. p. 345) of Mr. Distant's paper On the Mental Differences between the Sexes, the author is said to have referred to the "now moderately well established fact that in primitive races the *hair* of women approximates more closely to that of man than obtains in a higher state of civilisation." Mr. Distant in his paper referred to the *brain*, not to the *hair*.

A QUICKSILVER mine is said to have been discovered at Exeter.

M. GASTON TISSANDIER is publishing at Hachette's an excellent popular work on "Photography," with numerous illustrations. One of them shows Charles, the inventor of the gas balloon, photographing the silhouette of one of his pupils on a paper sensitised with one of the salts of silver, more than twenty years before the discovery of Daguerre.

IN his recent paper On the Placentation of the Sloths, published in the Transactions of the Royal Society of Edinburgh, Prof. Turner has done much to diminish the value of placental characters in the classification of the higher mammalia. In *Cholœpus hoffmanni* the placenta is dome-like, multilobate and genuinely deciduate, more like that found in the Primates and Man than in any other order, so much so that the author remarks "from the point of view of the descent hypothesis, it is possible that between the Sloths and the Lemurs genealogical relations may exist," and "now that I have called attention to the evidence of affinity with these higher mammals it is not improbable that other features of resemblance may in time be recognised."

BESIDES the ornithological papers which the late Mr. H. D. Graham contributed to the *Naturalist*, he left in the form of manuscript notes the larger and more interesting portion of the ornithological work which he had undertaken in the islands of Iona and Mull during the latter part of his life. These, together with the papers referred to, are being prepared for publication by Mr. R. Graham, to whom the whole of Mr. Graham's ornithological correspondence was originally addressed.

WE learn from the *Times* that M. Giard, Professor of Natural History at Lille, has been making an interesting inquiry into the zoology of the French shore of the Straits of Dover. Many uncommon species of crustaceans, ascidians, and mollusca have been obtained, which will be fully described before the Scientific Congress which is to be held at Lille during the ensuing summer.

WE are glad to see that Government have at last begun to carry out their agreement with the Trustees of the Bethnal Green Museum, by laying out the vacant space around the Museum in gardens for the recreation of the people.

IN the House of Commons, on Tuesday, Mr. Cowper-Temple obtained leave to bring in a Bill to remove doubts as to the powers of the University of Scotland to admit women as students, and to grant degrees to women.

THE month of April is a famous one in the annals of the French Academy for centenary anniversaries. M. Biot was born in April 1774, almost the same day when Louis XIV. died. M. Biot was a member of the Academy of Sciences and Academy of Inscriptions. It was also in this month that Maupertuis published the first French mathematical essay in which the Newtonian theory of attraction was accepted. Lavoisier was engaged in making observations on solar heat with an immense lens at the cost of one of the richest financiers of the time.

THE last (received) number of *Annales Hydrographiques*, contains details of the navigation of the Magellan Straits by the corvette *L'Atalante*, with tabulated meteorological observations made during the 13 days of the passage.

THE continuation of Adolph Schaubach's "Deutschen Alpen" (pp. 641 to 850) is brought up to the end of the Trias. The writer is Dr. H. Emmrich.

THE last number of the *Annales des Sciences Géologiques* contains a continuation of M. Oustalet's researches on the fossil insects of the Tertiaries of France. This second instalment of 112 pages is devoted to Aix-en-Provence.

THE recently published Report of the Department of Mines of Nova Scotia shows that the total produce during the year from collieries was 1,051,467 tons. Of these 264,000 tons were sold to the United States, 6,000 to Great Britain, 214,000 were used in Nova Scotia, and the rest were sold to Quebec, New Brunswick, Newfoundland, Prince Edward Island, West Indies, and South America.

A STAINED glass window has just been placed in the parish church of Folkestone to the memory of Dr. William Harvey, the discoverer of the circulation of the blood, who was born in the town in 1578. It is the gift of the medical profession, more than 3,000 of whom have contributed towards the cost.

IN view of the great economical value of the fur seals of Alaska, and of the importance of a thorough knowledge of their habits and movements, with reference to the command of the market of the world, it is proposed by the United States Treasury Department to send some one to the North Pacific Ocean for the purpose of obtaining materials for an exhaustive report on the subject. It will be remembered that these seals, almost to the number of millions, visit the St. George and St. Paul islands of the Pribylov group every summer season for the purpose of bringing forth their young, and that on this occasion a company chartered by the United States is allowed to capture 100,000 annually. What becomes of these seals after they leave the islands is entirely unknown, although congregated there in such numbers for several months. A few are taken in the spring and fall as they pass along the coast of British Columbia and Washington Territory, but whether these are related to the Pribylov army or not is uncertain. The same species is found to a limited extent on the Asiatic side of the ocean, but no very extensive captures are made. Should this commission be appointed, it is to be hoped that some of these problems may be solved, and that we may not remain longer in ignorance of the general natural history of so important an animal, which furnishes a revenue to the United States of about 300,000 dols. a year, while a profit of almost millions is made by the company which has charge of the interest.

THE additions to the Zoological Society's Gardens during the last week include a Vigne's Sheep (*Ovis vignei*), from Asia, presented by Capt. Archibald; a Sambur Deer (*Cervus aristotelis*) and an Axis Deer (*Cervus axis*), from India, presented by the Hon. Justice Jackson; two Cut-throat Finches (*Amadina fasciatus*) and two Paradise Whydah Birds (*Vidua paradisea*) from West Africa, presented by Lieut. J. H. Hearne, R.N.; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, presented by Mr. Hincks; two Negro Tamarins (*Midas ursulus*) from Rio de Janeiro; a Common Rhea (*Rhea americana*) from Buenos Ayres; a Brazilian Teal (*Querquedula brasiliensis*), and a Bahama Duck (*Pœcilonetta bahamensis*) from South America, purchased.

THE PHYSICAL HISTORY OF THE RHINE*

THE attempt to unravel geological history, as far as the stratified rocks are concerned, and all the igneous rocks connected with them, simply resolves itself into this:—an effort to realise the physical geography of different geological epochs, to make out the relations of the sea and of the land with its plains and mountains during these periods, the history of the rivers and lakes of the time, and to know as much as may be known of all the creatures and of all the vegetation which inhabited the water and the land.

I am now going to attempt to explain the history of that great historical river the Rhine. Every river has a definite history, if we could clearly make it out. Every river has had a beginning, and it is quite possible—if we have the skill—to find out when, by special changes in physical geography, such and such a river began to flow, and why it flows in such and such a direction.

In various publications I have attempted to show what is the history of some of the rivers of England; as, for example, the history of the Severn and of the Thames, and I think I have been able to prove that the Severn is a much older river than the Thames; and, on similar principles, I now propose to attempt to reveal to you the history of the Rhine and its

* A Lecture delivered at the Royal Institution on Friday evening, March 27, by Prof. A. C. Ramsay, LL.D., V.P.R.S., Director-General of the Geological Survey of the United Kingdom, &c.

valley from early times to the present day. For many years I had an ambition to work out the history of the Rhine. I have known it now for more than twenty years; going often up and down the river, and sometimes for weeks—once for months—living on its banks. For the last thirteen years, unfortunately, I never was able to return to it, but the problem I had marked out for myself remained in my mind, and last year I went, and worked it out, with the result which is now to be explained.

First, with regard to the great main features of the Rhine valley; it has its sources, as every one knows, in the mountain regions of Switzerland, one of which is in the valley of the Vorder Rhine, and the other in that of the Hinter Rhine, both glacier regions. The ground where it rises is from 7,000 to 8,000 feet above the level of the sea. From thence it passes to the Lake of Constance, 1,305 feet above the sea; and beyond, in a westerly direction, by Schaffhaussen to Basel, where, at the bridge, the level of the water has an average height of about 803 feet above the sea. Thence it flows down the great upper plain of the Rhine northerly between the Schwartzwald and the Vosges to Mainz, where the height of the river is about 531 feet above the level of the sea, thus showing a fall between Basel and Mainz of about 272 feet, which gives an average slope for the running of the river of about 3 ft. 1½ in. per mile. Beyond that, proceeding to the north, we come to the deep gorge of the Rhine, passing between high cliffy banks, which begin at Bingen and continue down to Rheineck in the neighbourhood of the Siebengebirge, for a distance of from 60 to 70 miles, according as you take into account all the windings or omit them. Beyond the Siebengebirge there is a plain, partly formed of the delta of the river, which gradually merges into the great flats that extend all the way from Calais to the Elbe.

Now the main question I have to bring before you is, first, what is the origin of the great upper plain that lies between Basel and Mainz? and, secondly, what is the origin of the gorge between Mainz and Rheineck? Why are they there, and by what means have this plain and this gorge assumed their present forms?

When you stand above Bingen, or, better still, if you ascend the Taunus and look southerly, and consider the narrowness of the gorge and the great hilly barrier of rock that must once have extended at Bingen across the lower end of the plain, the impression is irresistibly conveyed to the mind that before that gorge was opened a vast lake must have reached all the way from that barrier to where Basel now stands, covering the great plain that lies between the mountains of the Vosges and those of the Schwartzwald. And so thoroughly has this idea taken possession of the popular mind, at least of those who have at all considered the subject, that we find this statement made in some of the Guide Books of the time, and notably by Baedeker, where it is stated that a lake must have covered the whole of that vast plain, 170 miles in length, at a comparatively recent period. It is a very obvious theory and has much to recommend it, for it seems so clear that, before the gorge was opened, all that plain must have been covered with a sheet of water, and it is hard to realise that such has not been the fact. When I first entered on the subject I was impressed with this idea, and I began to cast about and endeavour to find a reason for the scooping out of the gorge, and for the consequent drainage of the supposed lake.

Having years before written a paper on the origin of the lake basins of Switzerland, North America, and other parts of the world, and having attributed the formation of many of these, but by no means all of them, to the action of glacier-ice during the glacial period, my first impression was that ice might have had at least something to do with the scooping out of the great valley that lies between the north flanks of the Jura, the Schwartzwald, the Vosges, and the Taunus. But while slowly passing up the river, and searching for proofs which might either confirm or contradict this view, I was soon obliged to give up the idea that glacier-ice had anything to do with scooping out the great hollow. For on one side—that of the mountains of the Schwartzwald—I found that none of the glaciers of that region (and there are proofs that glaciers once existed there) even extended well down into the valley of the Rhine. And on the opposite side of the Rhine Valley, that of the old glacier region of the Vosges, I found no proof that they ever extended down so far as the plain. There is also no proof that the glaciers of the great glacial epoch of Switzerland ever extended as far north as Basel. Neither are there any signs of erratic blocks or other kinds of moraine matter on the plains or hill-slopes about Bingen, which one might expect to find there had the whole of the great plain of the Upper Rhine been once filled with glacier-ice. Therefore this theory, which I had not definitely formed, but which I surmised might possibly have had something to do with the subject, entirely melted away, and other hypothetical views along with them, and I was obliged to begin anew.

Accordingly I went to Switzerland, and with the help of friendly Swiss geologists, examined part of the Miocene or Middle Tertiary rocks between the Oberland and the Jura.

To make the rest of the subject clear, I must now say a few words about the origin of mountain chains. Most people are familiar with the outlines of the nebular hypothesis. The whole solar system was once in a nebulous state, and as this nebulous mass revolved in space, portions of it were thrown off, and one of these consisted of the matter which, by and by, resolved itself into the present earth. This nebulous fluid, in virtue of gravity, by degrees condensed more and more, and, passing through what we may call the molten state, in the course of time began to assume a solid form, and a hard outer crust was at length produced which enclosed a highly-heated fluid mass within. This crust, which continued to thicken in consequence of radiation of heat, because of the law of gravitation, was ever drawn towards the centre of the earth. By this process the circumference of the earth necessarily became less, and that consolidated rocky sphere which formed the outer shell of the earth was forced to readjust itself so as to occupy a diminishing area. Thus it happened that while some parts sank, other parts of the crust were crumpled, and relatively raised higher than other portions of the crust that still retained their original curves as part of a sphere.

This hypothesis, which, as far as I know, was first propounded by Elie de Beaumont, may be looked upon as the origin of mountain chains. What began in the earlier and prehistoric times of geological history, seems to have been going on steadily down to the present day, and thus it happens, that geologists can prove mountain chains to be of very different ages, and that, of whatever age they may chance to be, the strata that compose them are found to be bent and contorted. This contortion of strata took place simply from that shrinking of the earth's crust which was the natural result of radiation of heat into outer space. Portions of the crust more or less gave way to lateral pressure, while other parts of the great spheroidal curve more or less retained what we call horizontal or nearly horizontal position.

In this way it happened that at a certain period of geological history which preceded the formation of the Miocene rocks in the region now occupied by the Alps, a disturbance of the earth's crust took place, due to shrinkage of the general mass, of such a nature that the Alpine strata were thrown into highly-contorted forms, and a great mountain range of pre-Miocene age was the result. On the north of these mountains the Miocene strata began to accumulate in great lakes. But these lakes lay so near the level of the sea, that every now and then, by depression of the land, they sometimes sank a little below the sea, and the sea invaded the area formerly occupied by fresh water. The result was that in Switzerland, between the Oberland and the Jura, and much farther north, the Miocene strata which are hundreds and sometimes thousands of feet thick, are now found to consist of interstratifications of marine, brackish, and of freshwater beds. At that time the Jura had no existence. It is the result of a later disturbance of the crust of the earth, and thus it happened that all the Miocene waters in which were deposited the strata that now lie between the Oberland and the Jura originally spread northwards far across the area now occupied by the Jura, and into the di-trict of the present plain of the Rhine between Basle and Bingen.

It is hard to realise the scenery of that time; but partly by an effort of imagination, and partly by special knowledge of the fossils contained in the rocks, it is possible to form some conception of the appearance of the country.

On the east and west of the great valley were mountainous ranges now called the Schwartzwald and the Vosges, while far to the south rose the high mountains of the pre-Miocene Alps, more or less covered with a forest vegetation. On the banks of the lakes there grew in an early stage of the Miocene epoch vast numbers of forest-trees and evergreen shrubs, of genera such as are now characteristic of tropical and sub tropical countries; figs and vines, many species of Protoaceæ analogous to those that still grow in the Australian continent, together with cypress, sequoia, cinnamon, fan palms, and palmettoes, ferns, hornbeams, and buckthorns, all of genera still familiar, but mostly if not altogether of extinct species. At a later date this vegetation partly died out, and was replaced by plane-trees, poplars, elms, willows, and maples; while cinnamons, figs, vines, laurels, and Protoaceæ still continued to flourish. In the woods, on the meadows, and in the waters respectively, the *Mastodon angustidens*, the rhinoceros, Chæropotamus, Dichobune, deer, Dinotherium, hippopotamus, crocodiles, salamanders, fish, and numerous other creatures roamed at pleasure, while the air and the land were tenanted by dragon-flies, ants, beetles, and other insects, of which more than 800 species have been distinguished.

I now come to the chief part of this lecture, which is to account for the origin of the Rhine: for at that earlier time the Rhine had no existence in this valley, and indeed there is proof that instead of the main drainage of the area, flowing from south to north as it does now through this valley, the waters drained from north to south; and the pebbles of the Schwartzwald, instead of being carried north as they are now, were carried southward by minor rivers, and found their way into Switzerland, thus helping to form some of the conglomerate rocks of which the Miocene strata of Switzerland to a great extent consist.

Not only had the Rhine no existence then, but the romantic gorge of the river, with which so many are familiar, had no existence either. It has been customary sometimes to attribute the formation of that gorge to violent disturbance and fracture of the strata, by which the waters were allowed to escape from south to north. I have no belief in such violent disturbances having any place in the modern economy of the world, nor yet in such cataclysmal action having ever affected the ancient world, as far as it is in the power of geologists to trace back events from the present day to the oldest known geological periods.

After the Miocene epoch had lasted for a long period of time, there occurred another disturbance of the European region, and of much of the rest of the world besides, though it is only the Alpine region and the countries north of the Alps that we have now to deal with. This second disturbance of the Alps produced a great upheaval of the Miocene strata. All the Miocene lakes that occupied the old lowlands of Switzerland and extended far east into what is now the Austrian dominions and into Asia itself,—all that area, as far as the Alps are concerned, was gradually heaved up high above the level of the sea, and those beds of conglomerates, sandstones, and marls that form the lowlands of Switzerland, and all across what is now the Jura, were disturbed to such an extent that the strata now forming the Righi and Rosberg and other sub-Alpine hills were partly raised to a height of at least 5,800 ft. above the level of the sea, and probably much more. The lower parts of Central Switzerland, about the Lake of Geneva, the Lake of Constance, and Neufchatel, still stand at heights of from 1,200 ft. to 1,300 ft. above that level. Then the range of the Jura first rose up to form a mountain-chain, and this is the proof of these disturbances. First we know that the Miocene rocks originally lay all the way from the Alps to the Taunus in flat-lying strata. During that period a vast quantity of Miocene pebbles were carried into the lakes, which were by and by consolidated into an exceedingly coarse conglomerate. Anyone who has ascended the Righi will remember that nearly the whole of it is formed of this coarse conglomerate, proving the prodigious amount of waste that the Alps underwent during the Miocene period. When we consider the amount of this waste, even though the waters of the Miocene period lay but little above the level of the sea, still in my opinion it is probable that the Alps themselves were then quite as high, if not higher, than they are now. For the prodigious amount of waste proved by the conglomerate, indicates the removal of an enormous amount of material from the pre-Miocene Alps.

After the disturbance which raised the Jura and the Miocene strata of the lowlands of Switzerland, this is what took place. Along with the contorted secondary strata of the Jura, the Miocene beds that previously covered them were thrown into a number of anticlinal and synclinal curves, and the greater part of the Miocene material over that area having since been removed by denudation, only a few outlying fragments of these strata remain, left in those wonderful upland basin-shaped hollows of the Jura, which still attest the original continuity of the Middle Tertiary deposits all the way from the base of the pre-Miocene Alps to the northern base of the Taunus.

When the post-Miocene disturbance of the whole of this area took place the general effect was, that much of the Swiss Miocene area was contorted and raised high into the air, while between the Jura and the Taunus, the equivalent strata were simply heaved up and tilted so as to form a long inclined plain sloping northerly and lying between the Vosges and the Schwartzwald, and the surface of which may have been about 1,200 or 1,300 ft. above the present level of the sea where Basel now stands, and about 1,000 to 1,100 ft. high where the opening of the gorge now begins near Bingen.

Before this wide-spreading disturbance took place, the Rhine had no existence, for up to that time such small rivers as occasionally ran in the more ancient Miocene valley flowed partly south. But when the inclined plain was fairly completed, the result in the long run was that for the first time the great general drainage of the area began to run from south to north, and the Rhine was established flowing at a height which we may roughly speak of as having been 500 ft. higher than now, because at that time all the great valley between Basle and Bingen was filled to that height with Miocene strata. We know this to be a fact by an examination of the valley on the right hand and the left, from Bingen towards Basle, for every here and there, we find table-shaped hills formed of flat-lying Miocene strata, which border the present alluvial plain of the Rhine and abut upon the more ancient mountains on either side. The history revealed by this fact is plain to anyone accustomed to reason on geological phenomena. The strata forming scarped slopes on opposite sides of the valley were once united, and their early continuity has been destroyed, simply by long-continued watery waste and denudation. They are indeed only the relics of an older phase of the physical geography of the district, when the surface of the plain stood about 500 ft. higher than it does at present.

Now when the Rhine first began to flow, the river then passed through a high upland valley with gently sloping sides that lay between the Taunus and the Hundsruck, and which in no manner resembled the precipitous cliffs that now bound the Rhine in the gorge below Bingen. The bottom of part of this old upland valley still forms a narrow terraced plain, immediately above and beyond the edge of the cliffy gorge of the Rhine. It is not always continuous on both sides of the gorge, but enough of it remains to attest its original continuity at heights of from 400 to 500 ft. above the present level of the river. Now what I wish to persuade you of is this, that the Rhine flowing in this valley by degrees began to cut out its own gorge, and that it was not produced by fracture. Every running river is busy eroding its channel, especially where the ground is at all steep. That is one of the main functions of running waters. They are constantly deepening their channels and carrying the sediments so formed from higher to lower levels, till in the course of time they find their way into lakes or the sea.

When we first enter the gorge of the Rhine, going southward, one feature that strikes the geological observer is the constant recurrence of this old terrace backed by the hilly country beyond. On the left bank, overlooking Bingen, the flat-topped spur of the Rochus-berg, about the same height as the tops of the neighbouring Miocene tabular hills, first strikes the eye. When fairly within the gorge below Niederheimbach, beyond its upper edge the old river plain is seen gently sloping to the north, while the sides of the gorge itself is seamed by numerous gullies worn by occasional torrents since the great ravine—a kind of canon—has been cut down to its present level.

At Welmich, below Niederheimbach, looking down the river, the edge of the terraced plain is seen receding northward in long perspective, and at Salzig, still further down, the features so well shown near Niederheimbach are again reproduced. The same outline occurs again and again all down the river between Bingen and Coblenz, and equally below Andernach, as for instance at Rheineck. Finally, above the Siebengebirge, just about the mouth of the gorge, looking up the river, the long eastern hills sloping to the river end in a terrace corresponding in general height and outline to those already mentioned. The general conclusion to be drawn from these observations is that at heights of from 450 to 500 ft. above the present river this ancient river terrace has a persistent gentle slope from south to north which approximately corresponds to that of the existing river.

The inference is plain: that formerly throughout the length of what is now the gorge the river flowed at that high terraced level, at a time when the plain above the gorge was so deeply filled with Miocene strata that the level of the river, where Mainz and Bingen now stand, was as high as the upland terrace that crowns the gorge between Bingen and Rolandseck. By degrees the river began to excavate the gorge, and slowly cutting deeper and deeper, and at the same time winding and ever changing its channel through the great plain between the Jura and the Taunus, by slow gradation it wasted away the surface of that plain more and more, and the matter won from that surface was carried down through the gorge to be added to the old delta of the river. At last the major part of the Miocene rocks that partly occupied the plain were worn away and the plain has been reduced to its present temporary level; while the terraced hills on either bank still remain to attest the amount of watery degradation that the area has undergone.

So much for the scooping out of the valley. But there is another point which I would like to impress upon you. On each side of the Rhine there are important tributary rivers. Thus, for example, above the gorge we have the Maine, the Neckar, the Kinzig, the Elz, and other streams, flowing through deep steep-sided valleys; and these rivers have from a very early period been tributaries of the Rhine. It follows, then, that when the level of the Rhine was 400 or 500 ft. higher than at present the levels of the bottoms of these rivers must also have been 400 or 500 ft. higher than at present; and therefore, just in proportion as the great valley of the plain of the Rhine was being cut down and lowered, so in proportion must the valleys in which these rivers run have gradually been deepened. When we come to the gorge the same kind of argument applies to the Moselle and other tributaries of the Rhine.

I have elsewhere attempted to show that at one time the Moselle ran as high as the top of the table-land that now bounds it on each side. Everyone who knows that river is aware that, though it looks so hilly when we go up the stream in a steam-boat, as soon as we reach the edges of the slopes on either side we are on the top of a great table-land intersected by numerous valleys, so that before the gorge of the Rhine was formed the Moselle ran at as high a level as the ancient Rhine; and just as the gorge of the Rhine was being deepened, so the Moselle was by degrees also enabled to deepen its channel. The same was the case with other rivers, right and left of the Rhine; and by applying this principle to the other great rivers of Europe we may hope in the long run to explain the physical history of all the systems of drainage of all parts of the continent.

One other point remains to be stated with regard to the physical history of the Rhine. Geologists well know that in older times the glaciers of Switzerland were on an immensely larger scale than at present. Large as they appear to us at the present day, they are of pigmy size when compared with their magnitude at a comparatively late period of the world's history. The Rhone glacier then spread across all the area now occupied by the Lake of Geneva, till it abutted on the Jura; and the old Rhine glacier extended all over the Lake of Constance, and reached at least half way from Schaff haussen to Basle. The body of water which flowed directly from such glaciers must have been very great, and enormous must the moraines have been that were shed from the ice-sheets. From an examination of the pebbles that form the superficial gravel on the present plain of the Rhine below Basle, it is certain that a large portion of them have come from the Alpine regions. Such a great moraine as was shed from the western edge of the old glacier of the Rhine was constantly being attacked by the waters that flowed from its end, and thus by degrees pebbles were carried onward into the plain. The result is that a large part of the gravels of the Rhine is simply the waste of old moraines shed from the glaciers of Switzerland, added to by material carried down by the streams of the Vosges and the Schwartzwald, also partly derived from he moraines of ancient glaciers on a smaller scale.

Last year it was my lot to deliver here a lecture on the history of old continents, and I attempted to show that one old continent in particular retained its identity through a very long period of geological time; that from the close of the Upper Silurian period, all through the Old Red Sandstone and Carboniferous periods, through the Permian and New Red Sandstone epochs, over great part of what is now Europe, that continent, with many physical changes, still retained its identity. Such a vast continent remaining through all those geological periods implies a succession of epochs of time, which, as far as years and cycles of years are concerned, the mind has as yet only hints of data which some day may help us to grapple with such a problem, and not till astronomy comes more boldly to the help of geology, may we begin to hope for the solving of the problem of the actual value of geological time. However that may turn out, it is certain that during the long continental epoch alluded to there were, over and over again, many changes in physical geography far greater than that petty change which I have been endeavouring to sketch out to-night. The floras and faunas of the world in that old time changed, not in the minor degree I have been speaking of to-night, but were more completely remodelled again and again in great part, even generically. Mountain ranges rose, glacial periods intervened and passed away. Great lakes, sometimes fresh, sometimes salt, appeared and were obliterated by great terrestrial changes. At one time vast lakes, like those of the heart of Africa and North America, covered prodigious areas of land; at another, equal or larger areas were covered by salt lakes as large as the Caspian and the Sea of Aral. And when you think of the continental episode in the modern geological history of Europe to which I have drawn attention, you will see how small it really is, though it may look large to our minds, compared to the old continental epoch of which I spoke last year. This you may depend upon, that though to the superficial eye it may seem as if the world had always been going on just as it is doing now, and that through all time to come it will go on just the same, with its mountains, valleys, rivers, lakes, and seas, yet it is none the less certain that changes, such as I have described to-night, are but the forerunners of other mutations as great, aye, and far greater, that will take place in the future. Just as there is as yet no certainly measured limit to the geological time of the past, so also we know of no measurable limit to geological time to come. But why should I keep you with words such as these, when I may convey a whole chapter in physical geology, condensed into eight lines, by the greatest of our living poets:—

There rolls the deep where grew the tree.
O Earth, what changes hast thou seen!
There, where the long street roars, hath been
The stillness of the central sea.

The hills are shadows, and they flow
From form to form, and nothing stands:
They melt like mist, the solid lands,
Like clouds they shape themselves and go.

SCIENTIFIC SERIALS

In the *Journal of Botany* for March, the editor, Dr. Trimen, commences a series of useful articles (which is continued in the April number) on the Botanical Bibliography of the British Counties, being a list of country and district floras arranged topographically. The other paper of greatest interest in this number is one of a kind of which this very useful journal has now published a considerable number, and which may ultimately throw considerable light on some of the problems connected with the distribution of plants, On the Flora of the Leeds and Bradford District, by J. A. Lees.—The number for April commences with an article of some importance in systematic botany, A Revision of the genera *Dryobalanops* and *Dipterocarpus*, by Prof. Thiselton-Dyer, in which a number of new species are described, including two belonging to the previously monotypic genus *Dryobalanops*, and illustrated by a plate (two more being promised in the next number). The editor also gives in this number one of the most valuable specialities of the journal, his list of New Species of Phanerogamous Plants in periodicals published in Great Britain during 1873.

The *Scottish Naturalist* for April publishes a number of papers on almost every branch of Botany and Zoology, including one on Geology, of more or less interest to Scottish naturalists.—Mr. J. A. Harvie Brown proposes the establishment of a Natural History Publication Society, something on the model of the original plan of the Ray Society, for the purpose of publishing original papers on Natural History, principally on Mammalia and Aves, and for reprinting in fac-simile rare and useful tracts, pamphlets, &c., on the like subjects.—We have also further instalments of the lists of the Lepidoptera and Coleoptera of Scotland, by Dr. Buchanan White and Dr. D. Sharpe. This quarterly magazine seems to fill a most useful place in forming a channel of intercommunication between naturalists north of the Tweed.

Memorie della Soc. degli Spectroscopisti Italiani, December. This number contains a paper be G. Lorengoni, On the Observation of a partial eclipse of the sun in May last, observed by the spectroscopic and direct view methods. He discusses at length the advantages and accuracy of each method, and concludes that the former method is the best of the two.—G. de Lisa gives a table of spots on the sun, observed at Palermo in December, giving a mean of about eight spots each day.

The January number contains a note that a new Spectroscopic Station has been established at Turin, and an equatorial by Fraunhofer has been erected there.—Prof. Draper contributes a paper on his beautiful diffraction of spectrum photographs, similar to the account of the same in NATURE some weeks ago.

Astronomische Nachrichten, No. 1,978.—M. M. Henry gives the elements of planet (126) Velléda, epoch 1874, January, 0·0 Greenwich M.T.

$$\begin{aligned} Mo &= 149^\circ\ 55'\ 51''\cdot 1 \\ \Pi &= 347^\circ\ 49'\ 11''\cdot 3 \\ \Omega &= 23^\circ\ 10'\ 12''\cdot 8 \\ i &= 2^\circ\ 56'\ 10''\cdot 6 \\ \phi &= 6^\circ\ 5'\ 31''\cdot 4 \\ \mu &= 930''\cdot 9792 \\ \log. a &= 0\cdot 3873777 \end{aligned}$$

Leopold Schulshof gives the following elements of the comet discovered by Winnecke in February last :—

$$\begin{aligned} T &= 1874, \text{ March, } 9\cdot 95342 \text{ Greenwich Time} \\ \Pi &= 300^\circ\ 36'\ 42'' \\ \Omega &= 31^\circ\ 31'\ 18''\cdot 2 \\ i &= 58^\circ\ 17'\ 14''\cdot 5 \\ \log. q &= 8\cdot 642852 \end{aligned}$$

The star in Perseus RA $2^h\ 13^m\ 56^s$ Dec. + $58^\circ\ 1'\ 53''\cdot 5$ has been observed by A. Krüger to have varied from 8·5 mag. to 10 mag. in November 1872, and to have increased to 8·5 again in January last.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, March 25.—John Evans, F.R.S., president, in the chair.—The following communications were read :—On the Upper Coal-Formation of Eastern Nova Scotia and Prince Edward Island, in its relation to the Permian, by Principal Dawson, F.R.S. The author described the Carboniferous district of Pictou county as showing the whole thickness of the Carboniferous system arranged in three synclinals, the easternmost consisting of the Lower series up to the Middle Coal-formation, and including all the known workable Coal-measures in the district—the second towards the west of the middle and the lower part of the Upper Coal-formation—and the third showing in its centre the newest beds of the latter. On the north the bounding anticlinal of the first depression brings up the New-Glasgow Conglomerate, which contains boulders 3 ft. in diameter, often belonging to Lower Carboniferous rocks, and represents the upper part of the Millstone-grit or the lower part of the Middle Coal-formation. The author regards this as representing an immense bar or beach, which protected the swamps in which the Pictou main coal was formed. The succession of the deposits above the Conglomerate was described in some detail as seen in natural sections. The Upper Coal-formation, as shown in the section west of Carribou Harbour, consists of—(1) Red and grey shales, and grey, red, and brown sandstones ; and (2) Shales, generally of a deep red colour, alternating with grey, red, and brown sandstones, the red beds becoming more prevalent in the upper part of the section. In Prince Edward Island beds apparently corresponding to these are found, and also gradually become more red in ascending. These are overlain, apparently conformably, by the Trias. The author gave a tabular list of 47 species of plants found in the Upper Coal-formation of Nova Scotia and Prince Edward Island, and stated that all but about ten of these occur also in the Middle Coal-formation. The number of species decreases rapidly towards the upper part of the formation ; and this is especially the case in Prince Edward Island, some of the beds in which are considered by the author to be newer than any of those in Nova Scotia. The plants contained in the upper deposits were compared with those of the European Permian, and a correlation was shown to exist between them, so that it becomes a question whether this series was not synchronous with the lower part of the Permian of Europe, although in this district there is no stratigraphical break to establish a boundary between Carboniferous and Permian. The author therefore proposes to name these beds Permo-Carboniferous, and regards them as to some extent bridging over the gap which in Eastern America separates the Carboniferous from the Trias.—Note on the Carboniferous Conglomerates of the Eastern Part of the Basin of the Eden, by J. G. Goodchild.—An Account of a Well-Section in the Chalk at the north end of Driffield, East Yorkshire, by R. Mortimer.—On Slickensides, or Rock-Striations, particularly those of the Chalk, by Dr. Ogier Ward.

Royal Horticultural Society, April 1.—Scientific Committee.—Dr. Hooker, C.B., Pres. R.S., in the chair.—Prof. Thiselton Dyer exhibited seeds of the plant called in gardens *Theophrasta imperialis*, sent from Rio Janeiro by Dr. Glaziou. From the evidence now forthcoming it appears that the plant belongs to a different family, *Sapotaceæ*.—Dr. Hooker showed a photograph from Mr. Russell, of Falkirk, of a fruiting specimen of *Encephalartos villosus*, sometimes called in gardens *Zamia Mackenii*. The plant is a native of Natal, and a similar species has been discovered on the Niger by Barter, and a third in Zanzibar, by Kirk. A plant discovered by Schweinfurth in Central Africa is probably the same as that mentioned by Kirk.—Dr. Masters presented a classified list with notes of species of Passiflora and Tacsonia cultivated in European gardens.—Mr. Renny made some observations on the drawing, by Montagne, of *Artotrogus*, exhibited at the last meeting, which together with the original specimens, Mr. Berkeley had been kind enough to allow him to examine leisurely. He was able to clear up a mistake which De Bary seems to have fallen into in his description of *Peronospora infestans* (Ann. des Sc. Nat., 4e sér., t. xx. p. 105, 1863). De Bary had not met with the resting spore of that species, but suggested that Montagne's *Artotrogus hydnocarpus* might be the desired organ ; but he had doubts on the point, as Montagne had written to him that he found it also on Turnip. The facts are, that Mr. Broome found a mould on decaying Turnip, which he sent to Montagne, who pronounced it to be a species of his genus *Artotrogus*, though he does not appear at any time to have supplied a specific name. He doubtless announced to De Bary that *Artotrogus* was to be met with on Turnip, and it was De Bary's assumption that *A. hydnocarpus*, the only published species, was the one spoken of. De Bary, having a confident belief that the various species of *Peronospora* are parasitic each only on the plants of one genus, or at most of one family, seems to have been thus led to the doubt he has expressed.

General Meeting.—H. Little in the chair.—Prof. Thiselton Dyer commented on the interesting plants exhibited. Amongst these were the two forms of *Primula verticillata*, one from Sinai the other from Abyssinia ; *Boronia megastigma*, a new Australian plant with a very agreeable smell ; the stem and foliage of the splendid Bamboo *Dendrocalamus giganteus*, in cultivation at Sion House ; and cut blooms of *Sterculia nobilis* from the same collection.

Entomological Society, April 6.—Sir Sidney S. Saunders, president, in the chair.—Mr. Frederick Smith made some interesting observations relative to the habits of the bee-parasites belonging to the genus *Stylops*.—Major Parry communicated a paper entitled Further Descriptions of Lucanoid Coleoptera ; and Mr. Smith read descriptions of the *Tenthredinidæ* and *Ichneumonidæ* of Japan, from the collections of Mr. George Lewis.—Further notes were read from Mr. Gooch, of Natal, respecting the destruction of the coffee plantations there, by Longicorn Beetles.

Royal Astronomical Society, April 10.—Prof. Adams, president, in the chair.—Mr. De la Rue gave a verbal description of a piece of apparatus which he had devised for carrying out M. Janssen's method of photographing Venus near to ingress and egress upon the sun's disc. The instrument is intended to be attached to the photo-heliographs and weighs less than 11 lbs., inclusive of a small driving clock, which carries a revolving plate of about 10 in. in diameter, on which small photographs of Venus and the sun's limb are to be taken in rapid succession. Lord Lindsay also described the form of instrument which he had devised for the same purpose ; it appeared to be very similar to that described by Mr. De la Rue, except that it is mounted on a separate pillar from the telescope in order to avoid tremors.—Lord Lindsay also read a paper On a Method of Determining the Solar Parallax, from observations to be made at the next opposition of Juno, which occurs in November of this year. He proposes, while in the Mauritius, to make a series of heliometric measures of the distance of Juno from the nearest fixed stars ; and by comparisons of the measures taken soon after Juno has risen above the eastern horizon with those taken before it sets at the western to determine the terrestrial parallax. By this method he will be able to make his measures during all the clear nights of the month or six weeks before and after opposition. And although the parallax will be considerably less than in the case of Venus, he considered that he had reason to hope that the probable error of the result would, owing to the number of the measurements and the ease of dealing with points of light instead of discs, be less than either in the case of the transit of Venus or the opposition of Mars.

Society of Biblical Archæology, April 7.—Dr. Birch, president, in the chair.—The following papers were read: On Four Songs contained in an Egyptian Papyrus in the British Museum. Translated with notes by C. W. Goodwin. Of these four songs three partook of the same nature, and were amatory compositions, written in a highly imaginative and poetical style with much voluptuousness of expression, having a very striking resemblance extending throughout whole passages, to the language of the Canticles. The fourth song or hymn is of a very different nature, and is evidently one of the solemn dirges used at festivals during the exhibition of the figures of Osiris, as related by Herodotus. This hymn is in the text ascribed to King Antuf, a monarch of the XIth dynasty.—Nimrod et les Ecritures Cuneiformes, by Joseph Grival (read in English). In this essay the author maintained that Merodach, under his Accadian name of "Amarud the eldest son of the Lord of Urhi," was identical with Nimrod the "géant chasseur" of the Septuagint.

EDINBURGH

Royal Physical Society, March 25.—On some Organisms found in the Stomach of the Herring, by F. W. Lyon.—Note on Entozoa, genus *Bothriocephalus*, found in the intestinal canal of a fish (*Cottus scorpius*), by James M'Bain.—On Recent Meteoric Chemistry, by Andrew Taylor. Mr. Taylor, in this paper, gave a *résumé* of the present state of our knowledge of the chemistry of meteorites.—On British Madreporiæ, by C. W. Peach, A.L.S. Mr. Peach read a paper on this subject, first stating that his attention had been drawn to the subject by a paper by Prof. P. Martin Duncan, on the Madreporiæ dredged by the explorers in the *Porcupine* in 1869 and 1870. He then exhibited a series of specimens he had collected in the seas of Shetland, Cornwall, &c., the most abundant being Caryophyllia, varieties *Smithii* and *Borealis*.—On the Fossil Plants of the Silurian Rocks of the Pentland Hills and of Sutherlandshire, by C. Wm. Peach, A.L.S. In this paper Mr. Peach showed that one of the large plants collected by Mr. Brown in the Upper Silurian rocks of the Pentlands was identically the same and in a similar matrix as the one collected by him in Sutherlandshire. This same plant had also been found in the Upper Silurian of the luaspe sandstones in Canada. He further said that the rocks in Sutherlandshire were Lower Silurian, thus showing that land plants—and of a pretty high type—came in much earlier there than from either of the other localities.

PARIS

Academy of Sciences, April 6—M. Bertrand in the chair.—The perpetual secretary announced to the Academy the loss which it had sustained in the person of M. P. A. Hansen, correspondent for the Astronomical section, who died at Gotha on March 28.—The following communications were read:—On Polygons inscribed in and circumscribing curves, by M. Chasles.—Solar Cyclones: conclusion of the reply to Dr. Reye, and observations concerning an article from the "Bibliothèque universelle" of Geneva, and a reclamation by M. Norman Lockyer, by M. Faye. The author has tabulated the dates, localities, times, velocities, &c. of thirty-one cyclones.—Earthquake shocks felt in Algeria on March 28, 1874; a letter from M. Ch. Sainte-Claire Deville to the perpetual secretary. The communication included a note from Captain Brocard, containing a seismo-graphic indication of the shocks.—Observations made at the Observatory of Toulouse during the months of February and March 1874, by M. F. Tisserand. The author communicated observations on the eclipses of Jupiter's satellites, and announced at the same time that regular observations of sun-spots had been organised with an equatorial of 0·108 m. aperture, after the method of Carrington.—Experimental researches on bi-hydrated sulphuric acid, by MM. Js. Pierre, and E. Puchot.—Scientific ascent to a great height made (in a balloon) on March 22, 1874, by MM. J. Crocé-Spinelli and Sivel. The authors had ascended 7,300 metres, the temperature at that elevation being $-22°$. The observations recorded in this communication are spectroscopic and physiological. Particular attention was given to the two obscure bands right and left of the double D line. At about 5,500 metres the right-hand band dispppeared, and the band to the left vanished at about 7,000 metres, thus confirming M. Janssen's idea of these bands being of terrestrial origin. The observers adopted M. Bert's suggestion of respiring oxygen to correct the effects of the rarefaction of the air. A carrier pigeon released at 5,000 metres tried at first to remount to its cage, but finally descended, describing curves of from 200 to 300 metres in diameter, with a velocity of translation of about 40 or 50 metres per second.—Action of electric fluid upon gases, third note, by M. Neyreneuf. The author promised from his observations a satisfactory explanation of the stratification of the electric light.—On a new process for the study and determination of the alcohol in wines, by M. Duclaux. The process depends upon the fact that mixtures of alcohol and water give for different compositions different numbers of drops when allowed to flow from a pipette of constant orifice. (The method is a practical application of Dr. Guthrie's researches upon drops to which no allusion was made.)—Note accompanying the presentation of new astronomical objectives of large dimensions, by M. Secretan. The largest was 24 centim. in diameter and had a focal distance of 3·25 metres. Its price was 6,300f.—On a new (electric) couple specially prepared for the application of continuous currents in therapeutics, by M. J. Morin.—On a system of continuous alarm signals to prevent railway collisions or collisions of ships at sea during foggy weather, by M. C. J. de Mat.—Geological considerations on the probable origin of the drift soil called *diluvium*, by M. E. Robert.—On the employment of coal-tar alkalies for the destruction of *Phylloxera*, by M. A. Rommier.—Direct construction of the centre of curvature in a point of the section made in a surface by any plane, by M. A. Mannheim.—On the diffusion between moist and dry air through a septum of porous clay, by M. L. Dufour.—Measurement of the electromotive force of batteries in absolute units, by M. A. Crova.—Density of hydrogen combined with metals, by MM. L. Troost and P. Hautefeuille. The observed density is about 0·625.—Experiments concerning combustion in the animal organisation, by M. P. Schutzenberger.—On the brominated derivatives of pyruvic acid, by M. E. Grimaux. The author described di- and tri-brompyruvic acids and touched upon the constitution of the acid itself.—Modifications employed in the preparation of iron reduced by hydrogen, for the purpose of obtaining the metal perfectly pure, by M. Crolas.—Note on the determination of lime in meteoric waters, by M. H. Marié-Davy.—On asphyxia from insufficiency of oxygen, by M. Félix le Blanc.—On the use of oxygen in ballooning, by M. W. de Fonvielle.—Injection of ammonia into the veins to oppose accidents caused by snake bites, by M. Oré.—On the functional irritability of the stamens of *Berberis*, by M. E. Heckel.

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