THURSDAY, JULY 18, 1889.

THE PROPOSALS OF THE COMMISSIONERS FOR THE EXHIBITION OF 1851.

THE Statement which the Commissioners for the Exhibition of 1851 have recently published, concerning their future policy in dealing with their Estate at Kensington Gore, is a reply to the memorial of the Metropolitan Gardens Association, a memorial in the same terms as that printed in NATURE of May 9 (p. 25). From the *Times* of July 9, it appears that various public bodies, Corporations, &c., who had memorialized the Commissioners, have been supplied with copies of this Statement. The result has been that further remonstrances have been addressed to the Commissioners. The Statement to which we refer is drawn up in ten paragraphs, the first of which quotes a sentence from the Commissioners' Charter of Incorporation, to the effect that they are to apply their resources "to increase the means of industrial education and extend the influence of science and art upon productive industry." By the side of this we may place a passage from the second Report of the Commissioners—the Report, in fact, which laid down in 1852 the broad lines upon which the Commissioners determined to act. The passage runs thus: "We are of opinion that if the surplus" (profits from the 1851 Exhibition) "were applied in furtherance of one large institution devoted to the purposes of instruction," &c., &c., "it would be productive of important results; whilst if subdivided amongst local institutions," &c., &c., "the effects produced would be comparatively insignificant."

The second paragraph of the Commissioners' Statement enumerates the number of museums and schools founded upon their estate, which form the "one large institution" originally contemplated. These, they state, prove "that their scheme has been in a great measure successful."

In the third paragraph the Commissioners argue in favour of now selling, leasing, or otherwise disposing of portions of their estate in order to do something more for promoting science and art than granting sites for public institutions. They then refer to the representations made to them, about 1878, by a deputation from certain large towns in England and Wales, with the object of obtaining funds which might be distributed as grants in aid to the formation of provincial Museums; and they explain why they rejected those representations at that time. The Commissioners' wisdom on that occasion has been justified by the number of important local municipal Museums of science and art which have been created by local effort, rates, and Government aid, as at Birmingham, Manchester, Nottingham, and elsewhere.

With respect to paragraph 5 of the Statement, which recognizes an expression of public antipathy "to the aggregation of public institutions in one locality" (South Kensington) of London, it may suffice to say here that the Commissioners did not feel the force of the arguments advanced against placing the Imperial Institute at South Kensington. But now, upon reconsideration, they admit the general justice of the representations from the country (eleven years ago) and from the metropolis (two years ago). They accordingly announce their intention "of disposing of portions of their estate for private building purposes" so as to raise "a considerable income" to be applied first to the reduction of the mortgage debt on their estate, and next to "the establishment of Scholarships" for science and art, and to the making of grants to "provincial local institutions."

This new departure was *in ovo* at least a year ago. Six months ago it was estimated that the portions of the "inner court" of the estate which the Commissioners were determined to sell "for private building purposes" would bring in an income of £10,000 a year. Recent circumstances have slightly modified the disposal of so large a portion of the "inner court" of their estate for private houses as was at first intended. There are difficulties in at once making a new public roadway from east to west across the northern gardens of the estate—it may be mentioned as a detail that this road is to be driven through the existing Science and India Museums—and housebuilders, not unreasonably, cannot come to terms with the Commissioners until these difficulties are got rid of. Instead, then, of aiming at £10,000 a year, the Commissioners contemplate getting an increase to their income of between £5000 and £6000 a year.

In thus diminishing their estimated new income by £4000 or £5000 a year, and so reducing it to £5000 or £6000 a year, we have it on good authority that the Commissioners do not intend to devote any of this money to the Imperial Institute. It is to be used, as shown in the Statement, (1) for the reduction of the mortgage debt, (2) for establishing Scholarships and Exhibitions, and (3) for making grants to "provincial local institutions." It is urged that no pressure in respect of clearing the mortgage debt on the estate exists. Last year it was £141,000. £5000 has just been paid off, so that it now amounts to some £136,000. In 1887, the announcement was made that in the three years from 1884 to 1887 the large sum of £40,000 had been paid off. The regular income of the Commissioners amounts to £12,000 from ground-rent and other sources, so that the repayment of the debt, under the mortgage upon the estate, is said to be in a healthy state, thanks to the shrewd economies and management of Sir Lyon Playfair. The founding of Scholarships and Exhibitions, as now proposed by the Commissioners, was certainly announced as one of the functions of the Imperial Institute. Accordingly the question has been asked, and not perhaps entirely without some sort of reason, why are the Commissioners to set about the same work as well, especially when in 1879 they decided against proceeding with a scheme of Scholarships which they had in contemplation at that time? An impression—as we now know, an erroneous one—is abroad that the revival of the Scholarship scheme and the sale of land for private houses are not due solely to an ingenuous wish on the part of the Commissioners to do the best for their public trust.

We are invited by those who disagree with the Commissioners to turn to the time when the Imperial Institute scheme was floated early in 1887, and when there was some discussion over the appropriation to the Institute of the land at South Kensington. Prof. Huxley warmly espoused the cause of an Imperial Institute, for reasons which he explained; but he regarded a congeries of Colonial and Indian commercial samples, reference libraries, conference and commercial intelligence rooms, deposited at South Kensington, as "fish out of water." Its proper habitat, according to the Professor, would be in the midst of men of business—in the City. To this a "Member of the Committee of Management of the Imperial Institute" responded by a letter in the *Times*, supporting the location of the Institute at Kensington, with arguments of economy, &c. He repeated, with a fervour which we are told might be ascribed to an original Commissioner for the Exhibition of 1851, and which should therefore have prevented the Commissioners from proposing to sell any part of their estate for building private houses, that the land at South Kensington had been "bought for the purpose of affording sites for public institutions by the far-seeing wisdom of the Prince Consort."

To elucidate the intentions of the Imperial Institute, Sir Frederick Abel gave a public address in the spring of 1887, in the course of which he said that "the organization of facilities, combined with material aid, to be provided to young artizans who shall afford some legitimate evidence of superior natural intelligence, and a striving after self-improvement, to enable them to abandon for a time the duty of bread-winning, and to work at one or other of the technical schools in London or the provincial centres, will be another object to which the resources of the Institute should be applied very beneficially." Not only was this to be in respect of "technical education," it was also to benefit "commercial education." Briefly put, one of the aspirations of the Imperial Institute was to establish Scholarships and Exhibitions for technical and commercial education. We can well understand the necessity at the time for publicly developing as fully as possible the intentions of the Institute. Half a million of money was openly quoted by its promoters as the amount necessary to the launching of the Institute. The recently published accounts show that the expectations of the promoters have not been completely realized, for not more than £300,000 has been collected for the Institute, and of that, some £140,000 has been set aside as an endowment fund to work and support the Institute. We may take it, then, that the Institute will start with an income of about £5000. Two years of "general administration," as it is termed, have cost £9134, of which £5236 went in salaries and wages. If these data of the expenditure, which has been incurred before the Institute is in working order, give any insight into what it will cost when at work, it is obvious that some portion of the Institute's proposed functions must be suspended.

But with this explanation of the situation, and notwithstanding the authoritative contradiction to the suggestion that the Commissioners are going to provide funds for the Imperial Institute, the Commissioners' opponents argue that, since many of the members of the Imperial Institute Committee are also Commissioners for the Exhibition of 1851, it is outside human nature to suppose that the ambitions of the one body exert no influence upon the actions of the other. And so, without actually putting money into the coffers of the Imperial Institute, the Commissioners may do as good, by undertaking the foundation of those Scholarships and Exhibitions which the Imperial Institute may not see its way to. It has been our wish, in thus frankly stating the objections and arguments which are raised to the Commissioners' proposals, to examine and discuss them in all fairness.

We may now at any rate dismiss the topics relating to the Imperial Institute, and offer a few remarks upon the Commissioners' proposals to establish Scholarships and make grants in aid of "provincial local institutions." The Commissioners are incorporated "to increase the means of industrial education, and extend the influence of science and art upon productive industry." One of their first steps, towards giving effect to the new proposals, must be to arrange for pulling down considerable portions of the buildings which house scientific and artistic collections. These operations will no doubt temporarily interfere with the study of those collections by the public from all parts of the country. This, however, is a minor point as compared with an apparent omission, on the part of the Commissioners, in framing their proposals, to take into account what the public have actually done towards establishing a system of science and art Scholarships, and towards securing grants in aid of provincial local institutions. A great organization, developed in the course of many years' experience, has arisen; it has, and must continue, to co-operate with local effort in extending the influence of science and art upon productive industry, so long as there is any local effort and any Parliament to appreciate that fact. This organization comes under the administration of the Vice-President of the Committee of Council on Education; its history and *modus operandi* are known to such Commissioners as Mr. Mundella, Sir Lyon Playfair, and Sir William Hart Dyke. The two former, it is almost needless to say, held the office of Vice-President before Sir William Hart Dyke, the present Vice-President. All these, however, have helped in continuing the policy of Mr. Lowe (now Lord Sherbrooke) and the late Mr. W. E. Forster—a policy, the central feature of which is to multiply the forms of Parliamentary aid to local bodies which take the initiative in themselves providing local means to extend the influence of science and art upon productive industry. Mr. Mundella, Sir Lyon Playfair, and Sir William Hart Dyke surely have brought their experiences before the Commissioners, in the discussions, upon the new proposals for Scholarships, and aid to provincial institutions. They must have told the Commissioners of the flourishing and growing co-operation between local effort and State aid; they must have explained the methods of its administration, and proved that experience and funds are necessary to pay for and organize an executive staff for the discharge of the same or similar functions towards science and art and local provincial institutions as are now discharged by Government. Roughly put, the Government aids to local effort are: (1) building grants for science and art schools; (2) grants towards the equipment of such schools; (3) grants towards the purchase of objects for local Museums; (4) grants towards founding local Scholarships and Exhibitions; (5) grants of national Scholarships and maintenance allowances whilst the holders of these Scholarships are undergoing instruction at one or other of the more prominent science and art institutions of the country; and (6) grants of Travelling Scholarships. The total cost of these varieties of grants, so far as Government is concerned, amounts, according to the Parliamentary Estimates, to not less than £20,000 a year. It is difficult to estimate how much local effort contributes, how much municipalities give out of local rates, how much private individuals give, &c. But putting aside great donations of tens, twenties, and thirties of thousands of pounds, towards building schools of science and art, technical schools, and provincial Museums, something like £40,000 a year are contributed by local effort, to meet which the yearly Government grant of probably £20,000 is made. It seems unlikely, but we shall gladly accept correction if we are wrong, that the Commissioners can allot more than £4000 a year for Scholarships and grants to provincial institutions. The beneficial and judicious administration of this £4000 would probably cost almost as much as if it were £20,000 a year. Have the Commissioners funds to pay for such administration? Apparently they have not. Will they therefore ask Government to administer their proposed grants? Government has certainly hitherto rather rebuffed advances of help made by the Commissioners, so that we confess to not at present perceiving how the Commissioners can successfully carry out proposals which seem to be beset with dilemmas.

On the other hand, if the Commissioners offer their aid to the country for its unconditional acceptance, it seems to us that they may be open to the charge of weakening local effort, and thus of decreasing the means of extending the influence of science and art upon productive industry. They realized, in 1852, that the subdivision of their means amongst local institutions would be productive of comparatively insignificant effects. A subdivision of smaller means, now that a new condition has arisen, does not under present circumstances appear to give better promise. The sacrifice of part of their estate, and the temporary disarrangement of a section of the national institutions upon it, are hardly warranted by what, at present, seems to be a scheme *in embryo*, the full development of which is not, in truth, forecast.

Without more precise information, therefore, we are rather driven to conclude that an effective and beneficial scheme of Scholarships and grants in aid of provincial institutions is beyond the reach of the Commissioners.

Under the presidency of the Prince Consort, the Commissioners took pains to collect a mass of information in regard to what had already "been done by the public in this country to promote the interests of science and the arts, and the diffusion of scientific principles amongst those engaged in their practical application." Thirty-six years ago they placed on record the evidence which led them to the opinion "that much zeal has been shown in this respect." If they would pause now, they might very well and usefully do again what they did thirty-six years ago—direct their inquiries particularly to the new developments and results of this zeal as demonstrated by its present co-operation with State aid. The result of such inquiries could but prove of high value to the Commissioners, and might, we venture to think, lead them to the conclusion that their present proposals are half a century too late, whilst the preservation of their estate, with its national institutions, including those already existing and those likely to exist, is really abreast of the serious wants of the time.

THE CYSTIDEA OF BOHEMIA.

Système Silurien du Centre de la Bohême. 1ère Partie, Recherches Paléontologiques. Continuation éditée par le Musée Bohême. Vol. VII. *Classe des Echinodermes. Ordre des Cystidées.* Ouvrage posthume de feu Joachim Barrande, publié par le Docteur W. Waagen. Pp. i.-xvii., 1-233; Plates I.-XXXIX. (Prague, 1887.)

TO few is it given to accomplish the life-work that they have planned. Joachim Barrande, vast though his self-ordained task was, came nearer to his goal than do most men. Before the death of the venerable author in 1883, he had made some way with the last volume of the colossal "Système Silurien du Centre de la Bohême." The present work was destined to form the first section of Volume VII., "Echinodermes du Système Silurien." The plates were ready, the general portion of the work written and partly printed, and, on his death-bed, Barrande was still tracing out the descriptions of genera and species. The book has been completed by Dr. W. Waagen, who was appointed, in Barrande's will, editor of this volume. His admirable preface is rendered of practical value by the insertion of a complete list of Barrande's writings from 1846 to 1881.

The work itself is on the plan and in the style already familiar to us. It opens with an historical and critical account of the literature dealing with the Cystidea of the thirteen Silurian regions of the world. The term Silurian is, of course, used in the broadest possible sense. Even Sardinia, as one of these regions, has a section to itself, though the cystids of Sardinia have had less written about them than the snakes of Ireland. This retrospect brings us to 1883; the few observations published between that year and the end of 1887 do not affect the present work.

The second chapter is devoted to the morphology of the Cystidea, chiefly as exemplified in the Bohemian fossils. The arms especially are discussed at great length, and several tables show their presence or absence in the various species as yet known to science.

Then follow the detailed descriptions of the genera and species of Bohemian cystids. No classification is followed. On p. 49 a classification is indeed proposed, according to the number of major openings in the calyx. This arrangement, however, is impracticable, and apparently unnatural. Its chief merit is its simplicity; and yet, as the author naïvely complains, it is not so incomparably simple as the attempt of a certain English palæontologist to classify Silurian cephalopods according to their curvature. The order of description is therefore alphabetical, the only divisions being those of the three faunas. Such an arrangement, however, by no means does away with the necessity for an index, and the absence of that indispensable aid to the practical worker is the one great fault that we have to find with the work. At the present time some 240 species of Cystidea are known, and these belong to about 70 genera. The Bohemian species number 78, two varieties worthy of a name, and one or two indeterminable fragments. Of these species, 76 are here described for the first time, and the majority of them belong to new genera, of which 23 are here established. There are also represented the genera *Agele-*

crinus of Vanuxem, *Atelecystis* of Billings, *Echinosphaera* of Wahlenberg, *Lichenoides*, *Trochocystis*, and *Rhombifera* of Barrande, the latter formerly referred by him to the Pteropoda; and, lastly, the undefined *Cystidea*, which is reserved for the reception of eight or nine doubtful forms, some of which may, at a future date, form the types of yet more genera. It should also be noted that one species —*Echinosphaerites infaustus*, Barr.—has been taken by Prof. Neumayr as the type of his genus *Arachnocystis*. The same authority refers the somewhat doubtful *Rhombifera mira* to *Stephanocrinus*, and points out that *Staurosoma* is the same as *Tiaracrinus* of Schultze.

The genera of this group have been peculiarly unfortunate in the names attached to them. It is no longer necessary for palæontologists to cumber their generic names with the termination *ites*. This peculiar corruption of λίθος seems to set a stigma on fossils, as though they never had been living beings after all. The neontologist is ready enough to throw stones at the palæontologist; there is no need for the latter to supply him with ammunition. Prof. Lovén dropped this affix when editing the Cystidea in Angelin's "Iconographia Crinoideorum," and surely the names are long enough without it. Of far more importance is the correct use of the terminations *cystis*, *crinus*, *blastus*, and the like. We extend indulgence to certain old authors who gave such names as *Agelecrinus* and *Cryptocrinus* to cystids before the Cystidea were distinguished as a class; but when once the divisions were recognized, we must suppose that the eminent palæontologists who used these terminations attached to them some meaning. Even in 1843 we find Messrs. Austin suggesting that the names *Sycocrinites*, Austin, and *Echinocrinus*, Agassiz, "require amendment, as their terminations imply affinities which do not exist." *Apiocystis* means a pear-shaped *Cystid*, just as *Apiocrinus* means a pear-shaped *Crinoid*: the two terminations are *not* interchangeable. Posterity, for whom we labour, will lament that we had not the strength of mind to correct such names whenever we saw them to be misleading; but we ourselves should surely blame most severely those who still add to our perplexity. Why, for instance, should Prof. von Koenen give the names *Corylocrinus* and *Juglandocrinus* to two genera which he himself describes as Cystidea? In no other branch of science would such a use of language to conceal thought be tolerated. The present work we are glad to find free from such flagrant absurdities. The errors of nomenclature are slight: the name *Atelecystis*, Billings, the validity of which was upheld by Dr. H. Woodward, is, though not consistently, supplanted by its synonym *Anomalocystis*; there is also a want of consistency in writing *Pyrocystites pirum*. No attempt, however, has been made to revise the nomenclature of cystids foreign to Bohemia, in which direction much will some day have to be done.

Chapters iv. and v. are devoted to the geological and geographical distribution of Cystidea in general and of Bohemian cystids in particular. Chapter vi. describes the variations seen in the Bohemian species. The seventh and last chapter discusses the connection of these species with those of other countries. These questions are worked out, from a statistical if not from a philosophical point of view, in a large series of tables; a few graphic curve-diagrams would have been a more helpful guide through the wilderness of figures. The numbers of the species found in the various beds of Bohemia are:—

c.	d1.	d2.	d3.	d4.	d5.	e1.	e2.	f1.	f2.
7	12	12	4	46	2	2	3	0	2

This vertical distribution agrees in its main proportions with that observed in almost all other countries. The chief exceptions are the States of New York and Wisconsin, where a relatively large number of species are found in the Niagara limestone, and England, where seventeen species are recorded from Ordovician beds and nine from the Wenlock limestone: none of the Wenlock genera occur in the corresponding beds of Bohemia. The geographical diffusion of the Cystidea is very slight; the most widely distributed genera are *Agelecrinus*, *Atelecystis*, and *Echinosphaera*.

These elaborate comparisons and tabulations are, however, a little bit out of place in dealing with such a heterogeneous assemblage as the Cystidea. They are not a class, but a collection of puzzles to which we relegate all echinoderms that will go nowhere else. Barrande does indeed attempt a definition (pp. 23-24), but not one character mentioned is common to all Cystidea. What one really looks for in such a monograph as the present are new facts that may throw light either on the connection between individual genera and other classes of the Echinodermata, or on the origin and meaning of the various peculiar organs. Taking as guide the motto of Barrande, *C'est ce que j'ai vu*, we shall enter into no speculations, but shall mention such facts of morphological importance as appear to be new. The state of preservation of the Bohemian Cystidea is exceptionally bad; but it would be hard indeed if so rich an assemblage had not yielded to such an observer some interesting results.

Following the order adopted by Barrande in his second chapter, we begin with the stem. The stem of the Pelmatozoa typically consists of a single series of cylindrical joints with a central perforation. In the earlier crinoids the lumen is comparatively large; in most stalked cystids it is still larger. In *Atelecystis*, *Mitrocystis*, and *Trochocystis*, the proximal part of the stem consists of a double series of alternating plates which are thin and inclose a large hollow. In *Arachnocystis* the whole stem consists of four or five series of alternating plates. In *Dendrocystis* the plates forming the upper part of the stem can only be distinguished by their smaller size from those forming the calyx; below they merge into the normal series of single joints. *Cigara Dusli* is the fanciful name given to a stem entirely composed of small irregular plates, and probably belonging to *Lapillocystis fragilis*. These facts forcibly suggest that the Pelmatozoan stem originated as a mere evagination of the perisome. The curiously elongate *Pilocystis* (Pl. II. Fig. 26) may represent a still earlier stage in its evolution.

The test of Cystidea has usually been regarded as composed of one simple layer of plates. Eichwald, in *Lethæa Rossica*, mentioned an epidermis, but seems in many cases to mean by this nothing more than the outer surface of the plates. Lovén, in his monograph on *Pourtalesia*, seems to assume the existence of three elements or layers in the test. Barrande, however, has been the first to conclusively demonstrate that in a number of genera the main layer of the body-plates is closed, both inside and outside, by thin "*épidermes*," which appear to have been partially calcified. *Aristocystis* is the genus affording the most abundant material for the study of these coverings, but they have also been observed in *Arachnocystis*, *Craterina*, *Dendrocystis*, *Neocystis*, *Orocystis*, *Proteocystis*, and *Rhombifera* (*i.e. R. bohemica*): of *Deutocystis* and *Pirocystis*, the inner lining is the only part known. In *Mitrocystis* the great difference between the internal and external impressions (*vide* p. 65) *may* be due to the presence of an inner lining. The outer layer is continuous, and covers up all the pores of the body-plates; sometimes it is even thick enough to conceal their sculpture and the sutures. The inner lining appears to have passed up into the pore-canals, and to have been itself pierced at those points. There is, of course, no reason to suppose that this structure of the test was common to all the forms which we call Cystidea, but the observations of Barrande have undoubtedly opened a new field of investigation.

It has hitherto been usual to classify the Cystidea according to the disposition of their pores. Facts recorded in the present work are opposed to such an arrangement. In the simplest type, canals run right through the inner lining and the principal layer of the test, usually in a curved course: we may call these "haplopores"; they are best seen in *Aristocystis bohemica*. In other species of *Aristocystis*, *e.g. A. subcylindrica* and *A. grandiscutum*, the distal ends of two adjacent haplopores are often connected by a horseshoe-shaped groove on the surface of the middle layer. In the allied *Craterina* this groove appears to have expanded into an oval depression into which open the two canals. This, the familiar diplopore, is also seen in *Proteocystis*. In all these forms the pores do not open to the exterior, but are closed by the outer layer: the horseshoe groove and the oval depression are therefore nothing more than closed horizontal canals connecting the vertical canals; in these genera, at all events, the canals can have had nothing to do with tube feet. The structure of the hydrospire elements in such forms as *Echinosphaera*, *Arachnocystis*, *Caryocystis*, is essentially the same; that is to say, two vertical canals connected by a closed horizontal canal: the only difference is that the two vertical canals are separated by a suture line instead of being on the same plate. From a position originally just beneath the outer layer these horizontal canals seem to have sunk into the main layer of the test, and in *Caryocrinus* they are actually internal. *Rhombifera* (*sc. bohemica*) and *Homocystis* show the gradual specialization of certain portions of the test as canal-bearers: here it seems that the horizontal canals become more developed in proportion; in fact, they appear eventually to assume the whole function, whatever it may be. In such forms as *Lepadocrinus* they alone remain, and here they no longer connect the adjacent plates, but are transformed into two separate sets of folds. As to the function of these organs, Barrande regards it as respiratory, but drops the term *hydrospire*, for the quaint reason that they show no *spiral* structure. Instead, he calls them *hydrophores*. But he also applies this term to certain organs which can hardly be homologous with pore-rhombs. Around an opening, the interior of the calyx appears divided into five compartments; from the opening there passes into each compartment a branch, which subdivides into five or six smaller branches, and each of these ends in a double tubercle. It is impossible to see whether these branches were hollow tubes or no; they have no connection with the exterior, except at the central opening. These *hydrophores palmées* occur in *Aristocystis*, *Pirocystis*, and *Craterina*, forms already abundantly provided with canals: though simulating the hydrospires of Blastoidea as seen in section, they have an exactly contrary position. Neumayr thinks that the opening which they surround is the mouth, and that they are subtegminal ambulacral grooves. How this can be, when their distal ends are unconnected with the exterior, is not easy to understand. Barrande, moreover, cannot say whether they are at the oral or aboral pole. A comparison of Figs. 28 and 32 on Pl. XXIX. suggests that they are at the aboral end, and that the large opening represents the axial canal of the stem. May they not be connected with nerve-cords passing from a chambered organ?

As regards the major openings of the Cystidean calyx, the accepted views are confirmed by Barrande. Somewhat unaccountably, however, he speaks of the anus of *Agelecrinus* as the mouth (p. 84); perhaps he intended to quote Vanuxem, in which case the oversight is the editor's. In addition to the mouth, anus, and genital pore, Barrande describes for *Aristocystis* a slit-like aperture close to the mouth. This he regards as an organ hitherto unknown. At the same time he points out that its position is similar to that occupied by the peculiar folded structure described by Volborth in *Sphaeronis Leuchtenbergi*. More closely still does it resemble the "reniform groove," or "semilunar pore," figured by Forbes in the fossils which he called *Apiocystis* and *Echinoëncrinus*. We notice that *Atelecystis* is still quoted as having anal and genital openings, although neither in this genus nor in its near relation *Mitrocystis* do the Bohemian species show them. The fact is that even in *A. forbesianus* they have never really been found; the appearances described are only accidental. The true openings in all the Anomalocystidae must be looked for in the neighbourhood of the arms.

Although Barrande enters very largely into the question of the arms, he has brought out no results of importance. The arms of *Arachnocystis infausta* are perhaps more developed than those of any other cystid: it is curious how closely they resemble the stem in structure; one would almost imagine that they had originated in the same manner. A similar structure is observable in the process of *Dendrocystis* which Barrande regards as a ventral tube: there is, however, no reason to call it anything but an arm; and at the same time we may remember that the ventral tube of *Poteriocrinus*, to which Barrande and Trautschold have compared it, is not improbably itself derived from an arm.

Such are the points of greatest morphological interest in this fascinating work. Many peculiar and wonderful forms, such as *Acanthocystis*, *Trochocystis*, *Neocystis*, *Mespilocystis*, *Ascocystis*, and *Cystidea nugatula*, must be passed by with mere mention. The question of classification we have left where Barrande preferred to place it—on the shelf. Systematists may even wish that many a one of these new forms had been left in the earth—*irrepertum et sic melius situm*—and not dug up to disturb existing arrangements. We would not, however, seem ungrateful; rather let us hope that the future parts of this volume, though deprived of the care of the great palæontologist, may be equally fruitful of new and interesting facts, and that, in the hands of Dr. Waagen, they may, no less than this one, add still fresh lustre to the name of Barrande.

TEXT-BOOK OF PATHOLOGY.

Text-book of Pathology. By Prof. D. J. Hamilton. Pp. 719. (London: Macmillan and Co., 1889.)

ABROAD, it is usual for a pathologist to devote his whole life and energy to one subject, and to pay little or no attention to the clinical side of disease, concentrating all his attention on the anatomical and histological aspect. This system has both its advantages and its defects. As his future success in life depends solely upon his reputation as a pathologist, he is stimulated to write frequently and much; and one practical outcome is a large number of books, in both German and French, on pathology. These are of very varying excellence, some being mere compilations of the current standard works, while a few represent the results of a mature experience. For naked-eye pathology, English students have an unequalled work in Wilks and Moxon's "Pathology," of which a third edition has recently appeared. Morbid histology is a science of comparatively recent date, and English authors have hitherto confined themselves to writing short manuals for students, which have been supplemented by translations of the more elaborate foreign works.

This "Pathology" is the first English book which has attempted, in its completeness, to compete with the larger Continental works, and as it is the outcome of several years' experience, of one who is already well known for the original work he has published on many of the questions, it will meet with a hearty welcome. The author takes a very wide view of pathology, and includes under this term morbid anatomy, pathological histology, physics, chemistry, and comparative pathology. Theoretically, this is undoubtedly right; but it is extremely inconvenient, when a book is overweighted by collateral subjects; and we think the author would be well advised in a future edition, to omit the chapters on bacteriology and on the experiments which he conducted to illustrate the circulation of the blood. The greater portion of the information on bacteriology is of necessity a repetition of what is given in any text-book on the subject, and is therefore superfluous, except for the purpose of making the book theoretically complete. The experiments on the circulation should be relegated to a book on physiology.

The book commences with a very full account of the method of making a *sectio cadaveri*, with which we would in the main agree. Our experience, however, is entirely opposed to the separation of the heart from the lungs in the body, as he directs. We believe much more may, in a difficult case, be made out if the lungs and heart be removed, and examined together, the amount of blood in the various cavities of the heart having been previously noted.

One of the most valuable portions of the book is that which deals with the preparation of specimens for the museum and for microscopical examination. For the preservation of intestines and other delicate tissues as jar-specimens in a museum, the author recommends a saturated solution of boracic acid; and for eyes, brain, &c., glycerine jelly. Full details are given for the preparation of large sections of the brain by the gelatine-potash method devised by the author, by which he has been able to uniformly expand the sections, so as to more readily show the course of the various bundles of fibres.

The middle third of the book is occupied by a discussion of general pathological processes. The phenomena of inflammation are very fully discussed, and the author gives a good *résumé* of the views now held on the subject, and also of his own conclusions. He considers the blood-pressure to be the cause of the extrusion of the corpuscles which occurs in inflammation. In discussing the phenomena of inflammation of the cornea, he concludes that at first there is an influx into the cornea, which distends the canals and breaks up the endothelial plates; as a consequence, the so-called branching cells of the cornea, which were really the liquid in the plasma spaces, disappear; at the same time the nuclei of the endothelial plates proliferate. The fusiform nuclei which used to be looked upon as the nuclei of the branching cells, he considers to be the nuclei of the fibrous bundles, and as these run in laminæ of parallel bundles, which lie at right angles to those of the adjacent laminæ, the so-called spear-head bodies are formed by their proliferation. The pus comes both from the connective tissue corpuscles and from leucocytes. In granulation tissue, the author holds that the capillary vessels are mainly old capillary loops from the subjacent tissue, which have been pushed up by the pressure of the blood inside them, when the tense surface of epithelium has been destroyed; and he draws attention to the absence of granulations in a wound on the pleura or peritoneum where the surface pressure is still kept up, and considers that the vessels found, when the pores of a piece of sponge applied to a wound become vascularized, are at first not new vessels, but those of the tissue which have pushed up into the pores.

The third part deals with the diseases of the various organs and tissues. Some interesting facts are given as to the means by which tubercle may be spread:—

(*a*) By inoculation. When the poison is introduced subcutaneously, the disease is reproduced with great certainty. It is remarkable, however, how rarely the disease is contracted through superficial scratches by pathologists; for, although tubercle bacilli have been found in *post-mortem* sores, the author thinks no one has become tubercular in consequence; but this is too sweeping a statement.

(*b*) Through ingesta. Rabbits and guinea-pigs readily become tubercular when fed upon tubercular tissues or sputum, while dogs are less readily infected. Herterich has recorded the case of a healthy widow with two children, who married a second husband who had phthisis, by whom she had three children. She herself became phthisical, and her two youngest children developed deep yellow-coloured ulcers on the mouth and fauces, and ultimately general tuberculosis. The children had been fed on food which the mother had previously chewed. Reich records ten cases of tubercular meningitis in a country village, occurring within fifteen months in the practice of a phthisical midwife, who was in the habit of sucking the mucous from the mouths of the new-born infants, and of blowing air into their lungs. Pigs fed upon the milk of tuberculous cows became tubercular in five weeks.

(*c*) By inhalation. Animals after a few inhalations of tubercular sputum, disseminated in a spray, readily became infected. Koch holds that no other substances than tubercular products when introduced into an animal will produce tuberculosis.

The *résumé* of the changes which take place in the blood in various diseases is most complete and up to date. The latter part of the book deals with the diseases of the circulatory organs.

Among alterations which are desirable in a new edition we would suggest that the forms for the *post-mortem* reports which occupy four pages should be omitted; or, if not, they should be made much more complete. Many important headings, such as lymphatic glands, joints, prostate, &c., are wanting. Fig. 25 is an unfortunate illustration of lardaceous disease of the liver in which the liver cells are affected, and should be replaced by a more typical case with healthy cells. We would demur to the statements that lymphadenoma produces great anæmia and infiltrates tissues—that is, in the sense in which sarcoma is said to infiltrate. The growths extend only along lymph-channels, and do not infiltrate outside these. On p. 82, sulphide of potassium should be sulphite.

We congratulate the author on the general excellence and practical nature of his book, and shall await with interest the second volume. The arrangement of the type, the paper, and the illustrations are unexceptionable, and reflect the greatest credit upon all concerned.

OUR BOOK SHELF.

A Graduated Course of Natural Science. Part I. By Benjamin Loewy, F.R.A.S. (London: Macmillan and Co., 1889.)

THIS is an admirable little book which has been prepared for the use of teachers and students in schools where elementary ideas of physics and chemistry form part of the course of training. It is intended for elementary students only, and it is not too much to say that the various experiments and inferences are well within the scope of every boy and girl of ordinary ability. It is but to be expected that during his twenty years' experience the author has become thoroughly acquainted with the difficulties met with by young students, and with the best methods of overcoming them.

An experiment is first described, and the inferences to be drawn are then discussed, the simple conversational style being especially suitable for young pupils. The subjects are arranged in a very natural order, and it would be difficult to suggest improvements. Very practical suggestions are made as to the best way of arranging for each student to perform the experiments. A simple board, about 3 feet long by 18 inches wide, temporarily screwed to the top of the desk, has been found sufficient to accommodate two or three pupils, so that it is an easy matter to have thirty or forty working at the same time. To make the book more useful to teachers, a series of questions has been put at the end of each chapter.

We strongly recommend the book to the notice of teachers likely to be interested in the subjects of which it treats.

Flora of Switzerland for the use of Tourists and Field-Botanists. By A. Gremli. Translated from the Fifth Edition, by Leonard W. Paitson. (London: David Nutt, 1889.)

ENGLISH visitors to Switzerland who happen to be interested in botany must often have regretted that they did not possess a really good hand-book of the Swiss flora. The translator of Herr Gremli's well-known work has provided a volume which will exactly meet their wishes. The original book has been widely circulated in Germany, and its materials are so ample, and so carefully and intelligently arranged, that it well deserves its popularity. In the fifth edition many improvements were made, and these are, of course, embodied in the present rendering. Mr. Paitson has also been able to include the new matter presented in the French translation by M. J. J. Vetter (1885), and corrections and additions published (1887) in the latest—the fourth—of Herr Gremli's supplements. Although the work is intended in the first place for persons beginning the study of botany, it contains much information with regard to new species that will be of service to more advanced botanists. We may note that the English volume is clearly printed, and that it is of a size convenient for the use of tourists.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Coral Reefs.

I AM obliged to Mr. Murray and Dr. Guppy for their courteous replies to my questions. Mr. Murray knows how pleasant a duty it is on the part of Admiralty surveyors to collect materials for the investigation of men of science like himself. Perhaps he will allow me to say that the theory of wave action spreading out the loose materials of a volcanic island is difficult to understand in view of the fact that islands in the same locality, such for instance as Mokongai and Wakaya in the Fiji Group, have their barriers far away from the land on exactly opposite sides. If he will excuse repetition, I desire again to point to the Exploring Isles, and to the great distance between the barrier and the island of Vanua Mbalavu; also to the fact that the waves, for all but a few days in the year, attack the island from a direction varying between south-south-east and east-north-east, principally east-south-east. Although there is much upraised coral at the north end of Vanua Mbalavu, the formation is chiefly volcanic.

The shallow nature of the Na Solo lagoon is, I presume, due to the detritus from the now sunken island, and the fragments from the reef washed over by the heavy seas at high tide. The bank west of Ono, in the Kandavu Group, is terminated by a sunken barrier, similar to that south of Viwa and north-west of Mbengha; and is not a continuous reef awash, because of the muddy streams from Ono sweeping to leeward, and also for the reason, admitted on all sides, that coral does not grow with so much vigour where there is no surf.

Dr. Guppy's simile, of an engineer having constructed and afterwards repaired a bridge, is not, in my opinion, a good one. A bridge is a structure accomplished on mathematical principles, good or bad. If good, it will stand; if bad, it will sooner or later fall. Mr. Darwin's theory, like other theories, is not capable of mathematical proof; and it is deduced from personal observation only in a very limited degree. The second edition of his work indicates, that after thirty-two years' further experience in weighing, deducing, and generalizing of a similar character in other branches of natural history, and receiving the views of those opposed to his theory on this special subject, he still adheres to his original opinion. The principle of his work was, in all cases, very much the same; and, considering the labour which he devoted to the first study of the question several years after he returned from his voyage, it is hardly conceivable that the origin and formation of coral reefs did not occupy a considerable share of his attention in the long interval between the publication of the first and second editions of his book. As to acquaintance with the objects of his writings, he had none, I presume, with that horrid creature with the swim-bladder from which he believed we are all descended; nor with most of the animals which have formed the connecting links between that distinguished progenitor and man; but, nevertheless, his great collection of facts and evidences have been of sufficient weight to revolutionize the history of creation, and to pervert hundreds of thousands from their faith in the poetical narrative of Moses.

However, Dr. Guppy is correct in saying that there are certain upraised ancient reefs in the Lau group of Fiji. Lieut. Malan was no doubt alluding to the islands of Tavuthá, Naiau, and Kambara, which have every appearance of atolls lifted out of the sea, for they are coral islands of considerable height, with an exterior rim and depression in the centre, between 150 and 200 feet deep. It does not follow that they may not form *now* part of a descending area; nor that the Bukatatanoa and Reid Reefs may not be participating in the movement. It is remarkable that only one reef has yet been discovered which connects the atoll awash with the island many hundreds of feet high which has been, to all appearance, an atoll in past ages. As far as I am aware, there is no island known, except Aldabra (which has a lagoon dry at low water, and is, therefore, an abnormal instance), of coral formation, with a lake in the centre and openings on the lee side; in such a stage as an atoll would be if it was elevated, say, 20 or 30 feet; nor do I believe that anyone has yet seen an upraised island *barrier* reef. The sight would be so phenomenal, that the news of its existence would speedily become public property. It must be remembered that, while proofs of upheaval are easily detected, direct *evidence* even, of subsidence, is most difficult to obtain. All searching under water is groping in the dark.

I may here remark, as it is our common object to arrive at the truth, and surveyors are not special pleaders, that there is an error in Mr. Dana's examples of subsidence (p. 310, "Coral Reefs," Darwin, third edition). Nanuku Islets are cays on a spur from a barrier reef, and Bacon Islets are formed of coral. It is unfortunate that these should have been inadvertently taken as types so late as 1885, three years after the charts were published, though it is easy to understand how Mr. Dana was mistaken in his first book when he had to rely simply on the excellent sketch made by the officers of Wilkes's expedition, to which he was attached; but these mistakes do not necessarily invalidate the conclusions of the experienced naturalist, who, had he thought of it, could have selected other and better examples from the same group.

It would be premature to discuss the cases of the Tizard and Macclesfield banks before Dr. Bassett-Smith records the results of his examination of the specimens collected, in pursuance of Captain Wharton's directions, chiefly by himself and Lieut. Parry, of the *Rambler*; but this much may be said—the existence of a submarine cliff is established in the former, and the sectional slopes have a great resemblance to those of mountains. The condition of the Itu Aba and its surrounding reef appears to favour Mr. Murray's views; but the general state of the reef does not, as far as I can see, disprove the theory of subsidence. The one Macclesfield bank section is not at all like that of a sinking mountain; and the condition of the coral on the top might indicate either a downward or upward movement, or neither. If we find, as in both these cases, a mixture of dead and live coral on the rim of an atoll, the inference seems more in favour of subsidence than elevation. It implies that a sudden descent to a depth beyond that in which the less hardy individuals of the species can flourish, has killed the growing insect; and that a new effort is being made to regain the surface. Specimens of reef-building corals were brought up from depths below even 30 fathoms; but, as far as the imperfect appliances which we have at present could help us, there was no evidence that *masses* of coral were at all common below 13 fathoms. The condition of the slopes could be safely compared to the banks of a river stream with the blades of grass growing thinner and thinner as the distance from the water was increased (Darwin, p. 111).

In the case of the Bukatatanoa, and other large reefs of a similar character, my difficulty with respect to Mr. Murray's theory is this: if corals commenced to grow on sediment which had lodged on a submarine inequality, why should nearly all parts have kept pace so evenly in their growth? The highest portion of the bank on which the Bukatatanoa Reef—according to the theory of Mr. Murray—rests, would surely not be around the sides, but somewhere in the centre. There would be a summit of some kind, to which the sediment would be first attracted. Is it not most improbable that first the pelagic organisms which are dead, and then the coral polyps which are alive, should maintain an even contour around three sides of a bank and many miles away from the highest part of it, and arrive at the surface of the ocean much about the same time? If it is said, How do you know it arrived at the surface at the same time? I point to the connected form of the barrier. According to Mr. Murray, had it not done so, it would have formed innumerable rings instead of being connected, without a break, for so many miles.

Reid Reef, to the north of Bukatatanoa, is a still more remarkable instance. Here, there is a feature, which Mr. Murray mentions, quite apparent, viz. the paucity of coral heads in a lagoon where the barrier is uninterrupted; but the difficulties which I have ventured to place before him are greater than ever: (1) Why should wave-action distribute a bank on the weather as well as the lee side of the land? (2) Why should the insect reach the surface simultaneously on all sides, as shown by the continuous reef and the uniformity of its breadth? To the best of my recollection, the islets within this barrier are of volcanic origin, but the point is not material.

With reference to Mr. Murray's explanation of the deficiency of reef under Mbuke Levu (Mount Washington), may I point out that it is of great assistance in showing why, when discussing subsidence, it is not necessary to hesitate for examples at those islands which have a barrier on one side and a fringe on the other. On a cliffy, steep side, the sinking fringe would, of course, remain very close to the new coast-line, and, if it assumed the barrier form at all, would rapidly become filled with pieces from the land.

The fragmentary character of the Great Barrier Reef of Australia does not seem to have excited the attention it deserves in this controversy. I believe that there are innumerable passages through it, and that, instead of being termed a "barrier," it might better be described as a collection of large patches.

W. Usborne Moore.

8 Western Parade, Southsea, July 9.

The Hailstorm in Liverpool.

Sunday, June 2.—A very sultry afternoon, with heavy thunder-clouds in the south-west and west, and continual rumblings from the same direction, the storm evidently passing over the Dingle and Toxteth Park. Soon after 3.30 p.m. lightning became visible and the storm broke.

At first a few large drops of rain fell, making patches of $1\frac{1}{2}$ to 2 inches in diameter on the cement. In a minute or two, large lumps of ice came slowly down, rebounding to an astonishing height. As the stones became more numerous they decreased considerably in size and fell with greater force. This lasted for ten or twelve minutes. The rain had nearly ceased during the height of the storm, but began again towards the end for a short time. I immediately collected some stones off the grass, and placed them in a dish on some blotting-paper.

They were evidently of two classes; the one having clear ice kernels, the other white misty ice. If the stone was large the kernel was surrounded with another coating of the opposite kind of ice, a dark line intervening between the two, and here and there I noticed a third or fourth layer.

Many in themselves spherical had a pear-shaped appendage, which, however, soon melted away. One or two (Fig. 4) had the second layer thinner than the others, making a hollow between the centre and exterior layer, both above and below.

I found one of a most curious construction (Fig. 3). The stone was all composed of white ice except at one end. The white ice seemed to terminate like the petals of a flower, closing in round a centre of clear ice. This construction was entirely formed below the surface, the stone being otherwise smooth. I could not take accurate measurements owing to the absence of a correct scale, but approximately the stones I drew measured as follows:—

	Breadth.		Width.		Thickness.
(1)	$\frac{12}{16}''$	...	1″	...	$\frac{8}{16}''$
(2)	spherical, about		$\frac{10}{16}''$.	...	
(3)	$\frac{15}{16}''$	...	$1\frac{8}{16}''$	...	$\frac{14}{16}''$
(4)	$\frac{14}{16}''$	...	$1\frac{4}{16}''$	...	
(5)	$\frac{14}{16}''$	...	$1\frac{5}{16}''$	...	$\frac{10}{16}''$

The stones had all a metallic taste and also a flavour of ozone.

I have examined some of the stones under the microscope. All have an air-bubble at the centre, and I thought in some I could distinguish a speck of sand or grit as well. The kernel appears to have infinitesimal cracks in the ice, going round the central bubbles in circles. Sometimes these are not spread out all round, but run up to the centre in spokes, widening out as they reach the edge. The dark line between the coatings appears to be composed of small pear-shaped air-bubbles lying with

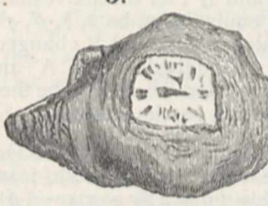
1.

2.

3.

4.

5.



their narrow end towards the centre, and here and there in the ring are specks of grit or dust.

In the pear-shaped prominences the minute ice cracks appear to be formed in waving lines.

In some (Fig. 4), the air-bubbles are formed near the surface round the second or third layer, and are much larger; in others (Fig. 5), they appear in the kernel instead of the spoke-like formation of cracks. C. D. HOLT.

Sefton Park, Liverpool.

Use or Abuse of Empirical Formulæ, and of Differentiation, by Chemists.

PROF. THORPE'S review of the work of Mendeleeff suggests to me a question I have several times previously thought of putting, viz. whether chemists are not permitting themselves to be run away with by a smattering of quasi-mathematics and an over-pressing of empirical formulæ. I do not make the accusation; I merely put the question as one suggested by an incomplete and superficial perusal of one or two recent memoirs.

To make my meaning clear, I will state a few facts, and if they are unnecessarily obvious I shall be glad to find them so.

Take percentage composition (p), and specific gravity (s); s is a function of p, and the question is, whether it is a continuous or a discontinuous function. To obtain an answer to this question, the best determinations of s should be plotted on a large scale in terms of p, with the probable limits of inaccuracy laid down, and then the curve should be examined to see whether it possesses, at the points of definite constitution, any kind of discontinuity, whether of slope or curvature. The answer may come out, either that such discontinuity certainly exists, or that it possibly exists, or that, if it exists at all, it must be below a certain specifiable order of magnitude. One of these is the definite kind of statement that can be made, and nothing else.

In order to assist the eye in forming a judgment, some form of mechanical integrator or differentiator might legitimately be run over the curve, provided due care were taken to avoid the creeping in of errors; but I doubt whether anything could be certainly detected in the derived curves that ought not to be visible in the original curve itself.

The process adopted by chemists seems a less satisfactory plan. I speak under correction. They assume some elementary form of empirical expression for the function, say a quadratic expression with three arbitrary coefficients, and they determine these coefficients to suit three points on the curve, first for one portion and then for another, taking these portions in the stages between one definite constitution and another; they thus obtain a set of quadratic expressions for s in terms of p, each with a more or less different set of coefficients: in other words, they find bits of parabolæ which more or less fit successive portions of the actual curve. They then differentiate each of these, and plot $\frac{ds}{dp}$, and they appear to be struck with the fact that, for each portion, these plottings come out precisely rectilinear; while with the observation that discontinuities exist between successive portions they seem quite pleased.

They sometimes go on to plot $\frac{d^2s}{dp^2}$, and to deduce fresh support for their facts by means of it.[1]

Now, were it not that eminent persons appear to lend their names to this kind of process, one would be inclined to stigmatize this performance as juggling with experimental results in order to extract from them, under the garb of chemistry, some very rudimentary and commonplace mathematical truths.

I would not be understood as casting any doubt on the *results* which may, by ingenious and clear-sighted persons, have been arrived at, even by so questionable a process: I would not be so understood, partly because those results lie out of my province, partly because the hypothesis of definite constitution for solutions or for alloys seems a very probable one, partly because I have myself plotted the s p curve for dilute ethyl alcohol, and clearly perceive the varieties of slope and curvature detected by Mendeleeff, though the changes are scarcely so sharp and definite at definite points as one might wish them to be in order to support the *a priori* improbable hypothesis of actual discontinuity. But what I want to assert, perhaps unnecessarily, is, that no juggling with feeble empirical expressions, and no appeal to the mysteries of elementary mathematics, can legitimately make experimental results any more really discontinuous then they themselves are able to declare themselves to be when properly plotted.

Liverpool, June 29. OLIVER J. LODGE.

[1] Although Prof. Thorpe's review *suggested* the writing of this letter there is nothing contained in that review which prompts these remarks. Prof. Thorpe does not appear to have fallen into the errors which, in the writings of some chemists, I fancy I detect.

CHEMICAL AFFINITY.

IN the older days, chemists were willing to think that, when they had said of a chemical occurrence, "It is a manifestation of the affinities of the reacting bodies," they had given a fair explanation of the occurrence. Nowadays, we rather avoid the term affinity. The modern chemist is not comforted by the word as his fathers were. Phrases, he knows, have a way of decoying a man to destruction. But, although he does not use the word affinity so much, the chemist is more eager than ever to understand the modes of action of affinity.

Since the latter part of the last century, the prevalent views regarding affinity have fluctuated between the doctrines of Bergmann and Berthollet. Bergmann taught that the causes of chemical action and gravitative attraction are identical; this cause being manifested, in one case, in an attraction between minute particles, and, in the other case, between comparatively large masses, of bodies. Further, he said that the result of chemical attraction between different kinds of particles is a change of composition wholly in the direction of the stronger attraction. Hence, according to Bergmann, substances may be arranged in the order of their affinities towards some standard substance. If A, B, and C are each capable of reacting chemically with D, and if the affinities of the three substances are in the order A, B, C, this means that addition of A to the compound BD, or to the compound CD, will cause the production of the new compound AD, and the liberation of B, or C.

Berthollet, like Bergmann, regarded chemical affinity as an attraction between minute particles; but he asserted that affinity is conditioned by the physical properties of the attracting bodies, and also, and very specially, by the relative masses of these bodies. A relatively small attraction may overcome a greater, if the mass of one of the attracting bodies is largely increased relatively to that of the other. Berthollet's view is expressed by himself in the words, "Toute substance qui tend à entrer en combinaison, agit en raison de son affinité et de sa quantité."

These two conceptions still divide the allegiance of chemists. Berthelot's *law of maximum work* is the modern form of the Bergmannic doctrine. Guldberg and Waage's *law of mass-action* puts Berthollet's statement into exact form, and includes in its expression the conception of equivalency—a conception which has been developed since the days of Berthollet.

A great deal of work on chemical affinity has been carried on within the last few years. Ostwald has recently published a memoir of first-class importance. The present seems a good opportunity for endeavouring to give a sketch of the position of the subject.

The enunciation of Guldberg and Waage's law of mass-action, and of the *principle of the coexistence of reactions*, marks the beginning of the distinctly modern era of the study of affinity. The law of mass-action, first clearly put forth by the Norwegian naturalists in 1867, states that *chemical action is proportional to the product of the active masses of the substances which take part in the reaction.* The *active mass* of any member of a chemical system is defined to be the mass of that substance, stated in chemical equivalents, in unit volume of the system. Thus, if in a solution of hydrochloric acid, sulphuric acid, and caustic soda, the substances are present in the ratio

$$2HCl : H_2SO_4 : 2NaOH,$$

the active masses of the three substances are 1, 1, and 1 respectively, H_2SO_4 being taken as one equivalent of sulphuric acid. The investigations of Guldberg and Waage, and others, more especially of Ostwald, have shown that, if more than one member of a system is undergoing chemical change, each change proceeds as if it were independent of the other, and each substance obeys the law of mass-action. This statement is called by Ostwald the principle of the co-existence of reactions.

But the amount of chemical change which occurs when substances react is conditioned not only by the active masses of the substances, but also by their chemical nature, their states of aggregation, the temperature, and other variables. In their first memoir, Guldberg and Waage grouped these variables together under the name *coefficient of affinity*.

Let two substances, P and Q, react in solution to produce P′ and Q′, and let P′ and Q′ by their reaction re-form P and Q; let the active masses of P and Q be represented by p and q, and the active masses of P′ and Q′ by p' and q'; further, let the coefficient of affinity for the reaction between P and Q be represented by k, and the coefficient of affinity for the reaction between P′ and Q′ by k'; then the amount of decomposition of P and Q which occurs will be proportional to the product kpq; and the amount of decomposition of P′ and Q′ will be proportional to the product $k'p'q'$. When the equation $kpq = k'p'q'$ is fulfilled, the system will be in equilibrium.

The ratio k'/k is found by throwing the equation into the form—

$$(P - x)(Q - x) = k'/k\,(P' + x)(Q' + x);$$

where P, Q, P′, and Q′ represent the masses, stated in equivalents, of the four bodies initially present, and x represents the number of equivalents of P and Q which disappear, and also the number of equivalents of P′ and Q′ which are formed, when equilibrium results. Experimental measurements of P, Q, P′, and Q′, and x are required; from these the ratio k'/k is calculated, and, from this, values are found for x for different initial values of P, Q, P′, and Q′.

In their earlier treatment of the equation of equilibrium, given above, Guldberg and Waage spoke of the force which brings about the formation of P′ and Q′ being held in equilibrium by the force which brings about the re-formation of P and Q. The word *force* was used with a somewhat vague meaning, and certainly not with the meaning given to it in dynamics. Following the example of van 't Hoff, in their later memoirs the Norwegian naturalists regard chemical equilibrium as resulting when the velocity of the direct change—*i.e.* in the above case the change of P and Q to P′ and Q′—became equal to the velocity of the reverse change, *i.e.* in the above case the change of P′ and Q′ to P and Q. The equation of equilibrium arrived at by applying this conception is identical with that already given. By *velocity of the change* is to be understood the ratio of material chemically changed to time used in the change. Ostwald's analysis of the criterion of equilibrium, viz. that the velocities of the direct and reverse changes are equal when equilibrium results, is somewhat as follows. Let two bodies, A and B, be changed to A′ and B′; let the active masses of the four bodies, stated in equivalents, be p, q, p', q'; let x be the number of equivalents of A and B changed to A′ and B′, and the number of equivalents of A′ and B′ changed to A and B, at any moment; and let ξ be the value attained by x when equilibrium results; then

velocity of direct change $= (p - x)(q - x)c$; and velocity of reverse change $= (p' - x)(q' - x)c'$; and the velocity of the total change $= (p - x)(q - x)c - (p' + x)(q' + x)c'$.

Then $x = \xi$, and the velocity of the total change $= 0$, *i.e.* equilibrium results, when

$$(p - \xi)(q - \xi)c = (p' + \xi)(q' + \xi)c'.$$

This is the same equation as that given by Guldberg and Waage. But in this equation c/c' represents the ratio of the velocity-coefficients of the two parts of the change, whereas the ratio k/k' was called the ratio of the affinity-coefficients.

The simplest case in which to apply the above form of the equation of equilibrium is when A and B are caused to react in equivalent quantities without addition of A′ or B′; in this case $p = q = 1$, and $p' = q' = 0$, and the equation has the form

$$(1 - \xi)^2 c = \xi^2 c';$$

hence

$$\frac{c}{c'} = \left(\frac{\xi}{1 - \xi}\right)^2.$$

By determining ξ, *i.e.* the number of equivalents of A and B changed, and $1 - \xi$, *i.e.* the number of equivalents of A and B remaining unchanged, when equilibrium results, the ratio of the velocity-coefficients is found. This equation has been applied to varied classes of changes. Thomsen's measurements, by thermal methods, of the distribution of a base between two acids when one of the acids interacts with the salt of the base with the other acid, confirm the equation. Ostwald's measurements, by volumetric methods, of the same reaction which Thomsen examined by thermal methods, also confirm the equation. And the equation is confirmed by the determinations, made by Berthelot and P. de Saint Gilles by chemical methods, of the quantity of ethereal salt formed when an acetic acid reacts with an alcohol. The accuracy of the equation has also been confirmed by applying it to physically heterogeneous systems consisting of solids and liquids or gases; Ostwald (in his "Lehrbuch der Allgemeinen Chemie") gives the necessary forms of the equation for different cases.

The law of mass-action, and the principle of the co-existence of reactions, are thus amply confirmed. But the expressions, reaction-velocity, or velocity-coefficient, or coefficient of velocity, must be analysed.

The ratio $\left(\frac{\xi}{1-\xi}\right)^2$ is called by Ostwald the *partition-coefficient* of the reaction. The square root of this ratio, *i.e.* $\frac{\xi}{1-\xi}$, is the same as the square root of the ratio of the velocity-coefficients of the two parts of the change, *i.e.* it is the same as $\sqrt{\frac{c}{c'}}$; it is also identical with the ratio of the affinity-coefficients, k/k'.

When equivalent masses of one acid and the sodium salt of another acid interact in dilute solution, ξ represents the number of equivalents of the salt which are decomposed, and $1-\xi$ represents the number of equivalents of the salt which remain unchanged, when equilibrium is established; or, to put the statement in another form, as each equivalent of salt decomposed produces one equivalent of acid and one of base, ξ represents the number of equivalents of base which have combined with the second acid, and $1-\xi$ represents the number of equivalents of base which have remained in combination with the first acid. The ratio $\frac{\xi}{1-\xi}$ then expresses the distribution of the base between the two acids. In the case of sodium sulphate (Na_2SO_4) reacting with nitric acid ($H_2N_2O_6$), Thomsen found $\xi = \frac{2}{3}$; therefore, the ratio $\frac{\xi}{1-\xi} = \frac{2}{3}/\frac{1}{3} = 2$. In this case, the direct change consists in formation of sodium nitrate and sulphuric acid, and the reverse change consists in the re-formation of sodium sulphate and nitric acid; the square root of the ratio of the velocities of the direct and reverse changes in this reaction is $\frac{2}{3}/\frac{1}{3} = 2$. Or, one may say that the ratio of the affinity-coefficients of the acids nitric and sulphuric for the base soda is $\frac{2}{3}/\frac{1}{3} = 2$. These statements are identical. Two-thirds of the soda combines with the nitric acid, and one-third with the sulphuric acid, when equilibrium is established; or the velocity of the direct change is double that of the reverse change; or the affinity of nitric acid for soda is twice that of sulphuric acid for the same base. It must be remembered that the acids and the base interact in equivalent quantities and in dilute aqueous solution.

Proceeding in the way indicated by the foregoing example, Ostwald determined the ratio $\sqrt{c/c'}$, or k/k', for many acids reacting with a given base; he stated these ratios in terms of one acid taken as 100. For instance, taking the base soda (Na_2O) the ratio for $\frac{H_2Cl_2}{H_2SO_4}$ was found to be 1·94, for $\frac{H_2N_2O_6}{H_2SO_4}$ 2·0, and for $\frac{H_2Cl_2}{H_2N_2O_6}$ ·97. If the affinity of nitric acid for soda is taken as 100, that of hydrochloric acid for the same base, according to these results is 97, and that of sulphuric acid is 50. Ostwald examined many different experimental methods for measuring the distribution of a base between two acids in dilute solution. The experimental difficulties are great, and the results obtained by one method cannot be expected to agree very closely with those obtained by another. Secondary reactions very often complicate the change which it is sought to measure. The order of the affinities of many acids, for a specified base, was not altered by a change of method, except in a few cases: in these cases the affinities were very small, and therefore incapable of accurate measurement by any of the methods tried.

Ostwald next proceeded to examine the influence of the nature of the base on the affinities of acids. He showed that whether the base be potash, soda, ammonia, magnesia, zinc oxide, or copper oxide, the ratio of the affinities of hydrochloric and nitric acids is the same; but that the ratio varies in the case of sulphuric and hydrochloric, or sulphuric and nitric, acids. But it is known that sulphuric acid reacts with its normal sodium salt to form an acid salt ($NaHSO_4$); Ostwald was able to explain the results obtained with sulphuric acid on the supposition that the affinity of this acid for a base, as measured by any of the methods used by him, really represents only the affinity of that part of the acid which has not combined to form an acid salt. He concluded that the true relative affinity of sulphuric acid, like the affinities of hydrochloric and nitric acids, is independent of the nature of the base. Extending the investigation to other acids, Ostwald concluded that the relative affinities of the acids are independent of the nature of the bases with which they react, and can be expressed by constant numbers. If this conclusion is accepted, it follows, from the nature of the reaction examined, that the relative affinities of the bases are also independent of the acids with which they react, and can be expressed by constant numbers. From these conclusions, the further deduction is made that the affinity between an acid and a base is the product of two specific affinity-coefficients, one of which belongs to the acid and the other to the base.

This conclusion is of extreme importance and requires rigorous examination. In order to test the accuracy of the statement that each acid has a specific affinity-coefficient, Ostwald has determined the affinities of a series of acids by different methods, with the result that the affinity-coefficients determined by one method are as nearly the same as those determined by other methods as could be expected, considering the errors inherent in the methods themselves. If each acid possesses a specific affinity-coefficient, the value of this coefficient for any acid might be expected quantitatively to condition many, if not all, the reactions brought about by that acid. Several chemical changes brought about by acids, other than those in which an acid interacts with the salt of another acid, have been examined by Ostwald. Among these changes may be mentioned that of acetamide to ammonia and acetic acid, that of methylic acetate to acetic acid and methylic alcohol, and that of cane-sugar to inverted sugar. The rate of each of these changes varies according to the acid added to the system; the results obtained show that the square roots of the ratios of the velocity-coefficients are in the same order as, and are as nearly identical as could reasonably be expected with, the ratios of the affinity-coefficients of the acids employed, as determined by the division of a base between these acids. Hence the conclusion that each acid has a specific affinity-coefficient is verified, and at the same time new methods for determining these coefficients are put into the hands of chemists.

But none of the methods employed was found altogether satisfactory. In every case secondary reactions more or less interfered with and complicated the primary change.

There is, however, another and altogether different method whereby the affinities of acids may very accurately be determined. This method is based on the relations which certainly exist between the rate of a chemical change brought about by an acid and the electrical conductivity of an aqueous solution of that acid. If the electrical conductivities of dilute aqueous solutions of a number of acids are stated in terms of that acid which has the greatest conductivity taken as unity, and the numbers so obtained are compared with the relative affinities of the same acids determined by one of the methods already described, a very close parallelism is noticed between the two series of numbers. By carefully studying the effect of dilution on the conductivities of monobasic acids, Ostwald has arrived at the conclusion that the dilutions at which the molecular conductivities of monobasic acids exhibit equal values bear a constant relation to each other. For instance, the molecular conductivity of monochloracetic acid at any dilution is equal to that of butyric acid when the solution of the latter is 256 times more dilute than that of the former acid. By *molecular conductivity* of an acid is meant the conductivity of a solution of a quantity of the acid proportional to its molecular weight. If μ = molecular conductivity, and λ = electrical conductivity, as ordinarily defined, stated in mercury units, then $\mu = 10^7 n\lambda$, where n = number of litres to which the molecular weight of the acid taken in grammes is diluted.

The conductivities of the stronger monobasic acids, such as nitric, hydrochloric, chloric, vary but little with dilution; the maximum values are reached in moderately dilute solutions. The conductivities of the weaker acids, such as phosphoric, acetic, butyric, however, vary much with dilution, and increase very considerably as dilution increases. The rate of increase varies; as a rule, the weaker the acid the greater is the increase for a specified dilution. The maximum values are not the same for all acids. Ostwald's investigations show that the affinity of an acid is closely connected not so much with the maximum conductivity of a solution of that acid as with the rate of increase of conductivity relatively to the maximum conductivity. To determine the affinity of an acid, by the electrical method, it is, therefore, necessary to determine the molecular conductivity of an aqueous solution of that acid at varying dilutions until the maximum conductivity is reached.

But it is very difficult, if not impossible, to determine directly the maximum conductivity of a solution of a weak acid, because when very much water is present the unavoidable impurities in the water affect the conductivity more than the minute quantity of acid which is present. Ostwald has found that the maximum conductivity of a monobasic acid in solution can be calculated from determinations of that of the sodium salt of the acid, and moreover that the maximum conductivity of the sodium salt can be calculated from the observed conductivities at different dilutions. The method by which these results are arrived at cannot be gone into here; suffice it to say that it is based on an extension and modification of the generalisation made by Kohlrausch, to the effect that the conductivity of an aqueous solution of a normal salt of a strong monobasic acid is the sum of two constants, one of which depends only on the nature of the acid, and the other only on the nature of the base.

The further application of the electrical method to find the affinity-coefficients of acids rests to a large extent on the extension made by Arrhenius to electrolysis of van 't Hoff's *law of osmotic pressure*. The law asserts that equal volumes of solutions of definite substances, at the same temperature and osmotic pressure, contain equal numbers of molecules, which numbers are the same as would be contained in equal volumes of gases at the same temperature and pressure. The law has been verified in different directions; it cannot, however, be accepted as a final statement. One conclusion drawn from the law of van 't Hoff, by thermodynamical reasoning, is that solutions of definite substances in the same solvent which have the same freezing-point exert equal osmotic pressures at their freezing-points; and hence, solutions which contain equal numbers of molecules in equal volumes, and which therefore exert equal osmotic pressures, have the same freezing-point. This deduction is identical with the *law of molecular lowering of freezing-point*, empirically established by Raoult. This deduction, if granted, enables the osmotic pressures of solutions to be calculated from observations of the freezing-points of these solutions; the calculated pressures can then be compared with those determined by direct experiment. There are many apparent exceptions to the law of molecular lowering of freezing-point, and to the law of van 't Hoff. Arrhenius explains the exceptions by supposing that the substances in question are partially dissociated in aqueous solution, and that therefore a specified volume of one of such solutions contains a greater number of molecules than would be the case if dissociation had not occurred. This explanation rests on the analogy between the gaseous state and the state of substances in dilute solution. As the pressure of the vapour obtained by heating ammonium chloride is greater than that calculated by Avogadro's law on the assumption that the vapour consists of molecules of NH_4Cl, but as the observed pressure agrees with the calculated pressure when the vapour is assumed to consist of equal numbers of molecules of NH_3 and HCl, so the apparently abnormal osmotic pressures of many solutions may be reconciled with the law of Van 't Hoff by assuming that the compounds in these solutions are more or less dissociated into simpler molecules. Substances which are not (by hypothesis) dissociated in aqueous solution are generally, if not always, non-electrolytes. The exceptions to the law of van 't Hoff occur chiefly, if not wholly, among electrolytes. Ostwald, following Arrhenius, supposes such electrolytes to be more or less dissociated into their ions in aqueous solutions.

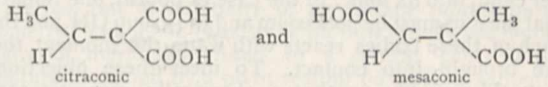
As this hypothesis of electrolytic dissociation rests on the identity of the laws expressing gaseous dissociation and dissociation in solution, it follows that generalisations made regarding gaseous dissociation may be applied to dissociations in solution. Suppose that a gaseous substance is dissociated into two gases; let the pressure of the undissociated portion be p, and the pressure of the dissociated portion be p_1; then, at constant temperature, the relation of p to p_1 is expressed by the equation $\frac{p}{p_1^2} = c$. Again, the pressure of a gas at any specified temperature is proportional to its mass, u, and inversely proportional to its volume, v: now, as the osmotic pressure of an undissociated compound in solution, according to the law of van 't Hoff, is equal to the pressure which the same mass of that compound would exert if it existed as a gas occupying the same volume as is occupied by the solution, the osmotic pressure in the solution, p, may be put as proportional to $\frac{u}{v}$; therefore, from the equation already given, $\frac{uv}{u_1^2} = C$.

Let μ_∞ = molecular conductivity of a binary electrolyte at infinite dilution, and let μ_v = conductivity of v litres containing one molecular weight in grammes of the electrolyte; then, the fraction μ_v/μ_∞ expresses the molecular conductivity at any stated dilution referred to the maximum conductivity, and on the hypothesis of electrolytic dissociation the same fraction expresses the portion of the electrolyte which is dissociated in terms of the whole quantity of the electrolyte taken as unity. If this fraction is expressed by u_1, and if u represents the undissociated portion of the electrolyte, we have $u = 1 - \mu_v/\mu_\infty$. If now we put $m = \frac{\mu_v}{\mu_\infty}$, and substitute in the equation $uv/u_1^2 = C$, we have $\frac{1-m}{m^2}v = C$. This equation states that $\frac{1-m}{m^2}v$ must have the same value for all dilutions of any one binary electrolyte; a statement which is amply confirmed by the researches of Ostwald. The constant C obtained by applying the above equation to a monobasic acid represents the affinity of that acid. The constant C measures the readiness of an aqueous solution of the acid to conduct electricity, as also its readiness to take part in chemical reactions; the value of C depends only on the nature of the acid, and is independent of dilution. As C has small values for strong acids and large values for weak acids, Ostwald prefers to put the equation in the form $\frac{m^2}{(1-m)v} = k$, where $k = \frac{1}{C}$. To avoid small fractions Ostwald multiplies m, and also k, by 100; he has determined $100k$ for more than 100 monobasic acids at dilutions varying from 8 to 1024 litres; finally, he expresses the most probable value of $100k$ as K. I cannot here give even a selection from the numerous measurements of K made by Ostwald, but must content myself with drawing attention to some of the conclusions he has come to regarding connexions between the affinities and the constitution of acids. The method has been worked out chiefly for monobasic acids.

In the acetic series of acids, affinity decreases from formic to propionic acid, and then remains nearly constant until caproic acid is reached. The substitution of chlorine or bromine for hydrogen in an acetic acid raises the affinity, bromine causing a smaller increase than chlorine. If S is substituted for O in the group COOH in acetic acid, the value of K is raised from ·0018 to ·0469; while the substitution of the group SH for H in the same acid is attended with an increase in the value of K from ·0018 to ·0225 only. The greater or less acidic character of such groups as OH, OCH_3, OC_6H_5, NO_2, &c., is quantitatively measured by the increase in the value of K attending the substitution of one of these groups for H in an acid. In the acetic acids, the change of H to OH is accompanied by an increase of affinity, OCH_3 is more acidic than OH, and OC_6H_5 is the most acidic of the three radicles considered. In studying the relations between the affinities of acids and their derivatives, attention must be paid not only to the composition and character of the replacing groups, and to the series of acids in which the replacement occurs, but also to the position of the replacing groups relatively to the other atoms of the molecules. The influence of position is very marked in the affinities of the isomeric oxy, chloro, nitro, methoxy, and acetoxy, benzoic acids. The following numbers exhibit the influence of the positions of the replacing groups:—

		K.
$C_6H_3 . COOH . OH . OH$	1 : 2 : 3	·114
,, ,,	1 : 2 : 6	5·0
$C_6H_5 . COOH$		·006
meta—$C_6H_4Cl . COOH$		·0155
ortho— ,, ,, ...		·132
meta—$C_6H_4NO_2 . COOH$		·0345
ortho— ,, ,, ...		·616
ortho—$C_6H_4 . OC_2H_3O . COOH$ ...		·0333
para— ,, ,, ,, ...		·00422
ortho—$C_6H_4 . OCH_3 . COOH$ ...		·00815
para— ,, ,, ,, ...		·00302

It is seen that the group OCH_3, or OC_2H_3O, substituted for H in benzoic acid, raises the affinity, if the group is placed in the ortho-position, but decreases the affinity if the group is placed in the para-position. The influence of the position of the replacing groups on the change of affinity of many acids points to some connexion between the affinities of acids and the space-arrangement of the atoms which form the molecules of the acids; measurements of the affinities of such acids as maleic and fumaric, mesaconic, citraconic, and itaconic, confirm this conclusion. Maleic acid is about twelve times stronger than fumaric acid; these acids are probably geometrically isomeric, and the COOH groups are probably nearer one another in maleic than in fumaric acid. Again, if the formulæ of Wislicenus for citraconic and mesaconic acids are adopted we should expect the former to be the stronger of the two. These formulæ represent the acids as geometrically isomeric; they are—



citraconic and mesaconic

The values obtained for K are, for citraconic ·34, for mesaconic ·079: the third isomeride, itaconic, is very weak; K = ·012.

Ostwald's researches open up a new path along which advance may be made: they show us how to connect the characteristic property of an acid, its affinity, with the constitution of the acid; they form a further and more important step towards solving *the* problem of chemistry, which is to find definite and measurable connexions between the properties and the composition of homogeneous kinds of matter.

But the coefficient of affinity of an acid has not yet been fully analysed. What is the meaning of the constant K? What is affinity? The value of K for a monobasic acid measures the readiness of that acid in solution to take part in chemical changes, and also the readiness of an aqueous solution of that acid to conduct electricity. Now, when a compound is electrolysed, the parts or ions into which it is separated are chemically equivalent and carry with them equal quantities of electricity, and the electricity travels only with the ions. The conductivity of the electrolyte will depend on the number of molecules electrolysed, and on the velocity of transference of the ions across the space separating the electrodes. The greater the number of molecules separated into ions, and the more rapid the migrations of these ions, the greater will be the conductivity of the substance. Hence the value of K for an acid will be conditioned by the amount of separation into ions, and the rate of migration of these ions; *i.e.* the affinity, as well as the conductivity, of the acid will depend on these quantities. The ions into which a monobasic acid is separated when electrolysis occurs are H and a negative radicle; the scheme of electrolysis may be represented as $HR = H + R$. As hydrogen moves much more rapidly than the most rapid negative acidic ion, the molecular conductivity of a monobasic acid in solution is chiefly conditioned by the degree in which the acid is separated into its ions. The affinity of the acid is sometimes dependent to a considerable extent on the velocity of the negative ion: in such cases acids which are separated into their ions to an equal extent will exhibit different affinities; in other cases the degree of electrolytic separation is the chief factor conditioning the affinity. Now the fact that, so far as accurate research has gone, electrolytes fully obey Ohm's law, or, in other words, the fact that the smallest electromotive force suffices to cause electrolysis, points to the action of the E.M.F. in electrolysis as being only a directive action on the ions already existing. This view of electrolysis has been developed by Clausius, and recently by Arrhenius, van 't Hoff, and Ostwald. The hypothesis, in its present form, bids us regard an aqueous solution of an electrolyte as already more or less completely dissociated; it bids us see the molecules of the electrolyte in the solution as dissociated into their ions; it says that the electrolytic and the chemical activity of the solution is dependent on the ratio between the number of dissociated, or "active," molecules, and the number of undissociated, or "inactive," molecules. This view of electrolysis, and of chemical change occurring between electrolytes, regards an aqueous solution of a strong acid as containing a great many free ions, which are, respectively, hydrogen and a negative radicle; it looks on an aqueous solution of a weak acid as containing only a few free ions.

There are difficulties in the way of accepting the hypothesis of electrolytic dissociation. At first sight one is shocked by being told that a very strong acid such as nitric acid, or a very strong base such as potash, is dissociated in aqueous solution, to perhaps 90 per cent., into its ions; in the case of potash, one remarks that the ions must be potassium and the group OH, and that each of these bodies reacts with water the moment they are brought into contact. To meet these objections, Ostwald reminds us that a chemically energetic compound is one which readily suffers chemical change, and the parts of which are therefore readily separated; and he remarks that the *ion* potassium is not the same thing as ordinary potassium; the ion holds a large electric charge; when it comes to the electrode it gives up this charge, and *then*, but not till then, it reacts with water. But difficulties still remain: one of the greatest is to explain the mode of action of the solvent. Does the solvent merely form a medium in which the separate ions move about? Why then does increase of solvent increase the amount of dissociation? May not the solvent react with the dissolved body to form complex molecular aggregates which then dissociate into simpler ions? Is the dissolved body the electrolyte, or is the electrolyte a compound, or aggregate, made up of the dissolved body and the solvent? Is the electrolyte actually separated into its ions in the solution, or does it only exhibit an "aptitude for directed dissociation"? These questions, and questions such as these, have yet to be answered.

The hypothesis of electrolytic dissociation has been worked out in detail in several directions, by Arrhenius and Ostwald, and has been found to give results in keeping with experiment. In considering its application to explain chemical change between electrolytes—for it really presents a theory of chemical changes between electrolytes—it is necessary to remember that, in its present form at any rate, it is applicable only to substances in aqueous solution. Because a solution of hydrochloric acid is very chemically active, it does not follow that liquid HCl should also be chemically energetic; nor, because gaseous HCl is not dissociated by heating to a fairly high temperature, does it follow that an aqueous solution of this compound should not be largely dissociated into the ions hydrogen and chlorine.

The hypothesis of chemical change between electrolytes in solution, which is based on van 't Hoff's extension of the law of Avogadro to substances in dilute solutions, and on the general close agreement between such dilute solutions and gases, cannot yet be finally accepted or rejected by chemists. It has already done much to draw closer the connexions between chemical and electrical phenomena, it has gone further than any other hypothesis of chemical change in helping forward the solution of the main problem of chemists, and it has opened up many new lines of advance.

There is one general conclusion to be come to from the study of all the recent work on chemical affinity: I think we may agree with Ostwald when he says that Bergmann was certainly right in assigning a definite affinity to each element and compound, and that Berthollet was right in asserting that affinity is modified by the relative masses of the reacting bodies, but that Bergmann erred in saying that chemical change always occurs in one direction only and that the direction of the strongest affinities, while Berthollet also erred in regarding the affinity between acids and bases as inversely proportional to the equivalent weights of the reacting compounds. Bergmann's error has been revived in modern times; it has now assumed a physico-chemical aspect; it finds its expression in Berthelot's so-called *law of maximum work*, which asserts that every chemical change accomplished without the addition of energy from without tends to the formation of that body or system of bodies the production of which is accompanied by the development of the maximum quantity of heat. In so far as this statement can be translated into precise terms it can be proved to be dynamically unsound. When applied to chemical reactions, it tells us that of several possible reactions that one which is accompanied by the production of the greatest quantity of heat occurs to the exclusion of others; but this has again and again been experimentally disproved.

M. M. PATTISON MUIR.

THE PASTEUR INSTITUTE.

LAST week the Lord Mayor received a letter from M. Pasteur, acknowledging receipt of the resolutions passed at the recent Mansion House meeting. In this letter M. Pasteur writes:—

"If the aphorism that science has no country has never received authoritative sanction, it did so at this meeting, in which the leading *savants* in biological and medical science of the United Kingdom took part. I wish I could thank them individually for having attended this gathering. I was filled with gratitude on learning that the Prince of Wales himself had accorded his high approbation of your initiative. Modesty compels me to pass over in silence the kind words of which my labours and those of the Pasteur Institute have been the subject, but I have a right to rejoice with all friends of the progress of humanity at the great moral effect of the meeting. The manifestation of July 1 had not only for its object the question of the treatment and possible extinction of hydrophobia in England, but in the nature of things it was also a protest against that false sentimentality which led certain persons, not—which was already a strong point with them—merely to put on the same footing the life of men and that of animals, but even to prefer the existence of animals to the salvation of human life. When this view is taken, what is the limit? We must become firm vegetarians. We must even extend our scruples so that no living being is sacrificed. We must endure the importunities of a mosquito, the daring of a mouse, the stings of a flea—false ideas or excuses for a tirade which one finds is most often at the bottom of all the attacks on experimental physiology. Certain credulous souls—by I know not what tales—imagine that our laboratories are chambers of torture. They ignore the fact that the rabbit or the guinea pig is rendered insensible by chloroform before it is subjected to the most insignificant operation. As for me personally, the suffering of an animal affects me so much that I would never shoot a bird, and the cry of a wounded skylark pierces me to the heart; but if the investigation of the mysteries of Nature and the acquisition of new truths be at stake, the sovereignty of the object justifies all. Who, then, having the least regard for the pursuit of the knowledge of the mysteries of Nature, would put in the balance the sacrifice of a few fowls and rabbits with the discovery of the attenuation of virus and prophylactics which have resulted from such sacrifice? No one, my Lord Mayor, will have contributed more than you have done to rectify the errors which under a show of compassion can only hinder the progress of science and compromise even the most legitimate interests of humanity."

THE TERRESTRIAL GLOBE AT THE PARIS EXHIBITION.

SOME time before the opening of the Paris Exhibition it was announced that one of the attractions of the show would be a great terrestrial globe, one millionth of the actual size of the earth. This globe is now exhibited in a building specially erected, near the Eiffel Tower, for the purpose, and it excites the warmest interest among all visitors who have devoted the slightest attention to geographical science. It was designed by MM. Villard and Cotard, and these gentlemen, who have received many congratulations on their success, have lately issued an account of the manner in which their project has been realized.

Maps on a plane surface give, of cause, a very inadequate impression of the real appearance of our planet; and ordinary globes are too small to indicate, even vaguely, the extent of the spaces represented on them. The idea of making a globe one millionth of the size of the earth deserves, therefore, to be described as a "happy thought," for, although the meaning of a million may not be fully appreciated, it is not absolutely inaccessible to the human mind. When we see a place or a district marked on a globe, and learn that the reality is a million times larger, the proportions are impressively suggested, with at least some approach to accuracy.

The diameter of the globe constructed by MM. Villard and Cotard is 12·73 metres. It has a circumference of 40 metres, and a millimetre of its surface represents a kilometre. The globe consists of an iron framework made chiefly of meridians united to a central core. This structure is carried by a pivot resting on an iron support. To the meridians pieces of wood are attached, and on these are fixed the panels composing the surface of the globe. These panels are made of sheets of cardboard bent by hand to the required spherical shape, and covered with plaster specially hardened. Fig. 1[1] shows how they are applied to the underlying structure. The total surface

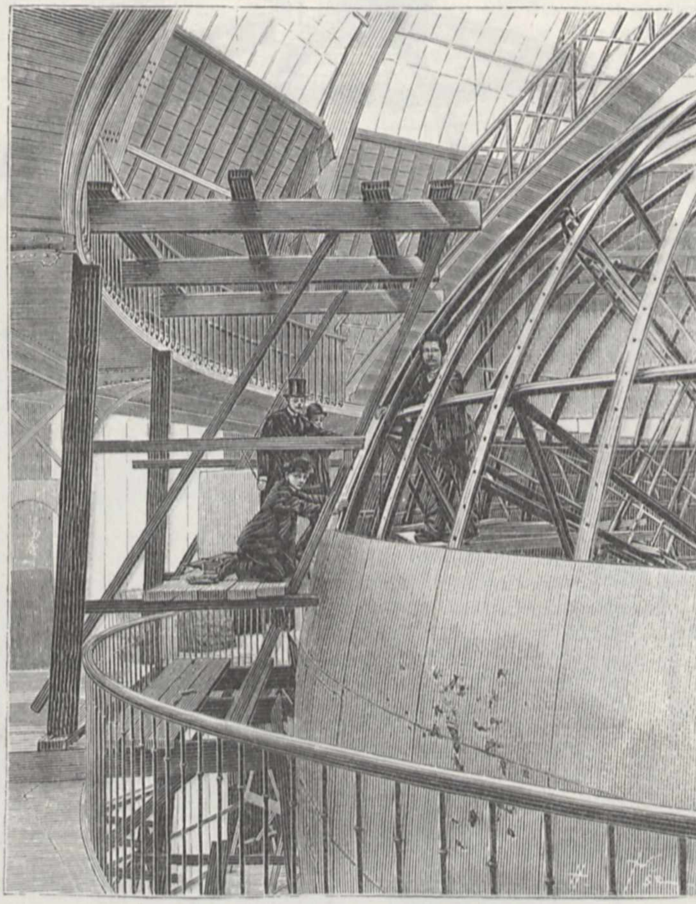


Fig. 1.

is divided into forty spindle-shaped spaces, the breadth of each of which at the equator is exactly one metre. Each "spindle" is itself subdivided, so that there are 600 panels of various dimensions. The designs are painted on the panels before they are put in their place, in order that the globe may ultimately be easily dismantled and removed.

The edifice in which the globe is shown has a metallic framework forming a cupola. It is lighted from above, and by the great glass frames of the sides. From a terrace or narrow foot-bridge at the upper part the visitor can see the polar and temperate regions of the northern hemisphere. As he descends, he is able to see in succession all the regions of the globe to the south pole. At the bottom he comes to the support of the globe with the apparatus for putting it in motion (Fig. 2).

Even the loftiest mountains, if shown in relief, could only have been represented by elevations a few millimetres in height. Consequently the various mountain ranges have been painted on the surface. The various depths of the ocean are indicated in a similar manner.

To facilitate the study of the globe, it has been mounted with its axis vertical, and it may be turned upon the pivot which carries it. If its rotation were made to equal that of the earth, at its equator, a point of its surface would move at the rate of half a millimetre in the second. This

[1] We are indebted to the editor of *La Nature* for the figures here reproduced.

movement would scarcely be visible, but it would, of course, represent an actual movement of the earth over half a kilometre in the same time.

A figure of the moon, corresponding to this one of the earth, would have a diameter of 3·50 metres, and would be 384 metres distant. A like figure of the sun would have a diameter of 1400 metres, and be distant about 150 kilometres. The diameter of a globe representing Jupiter on the same scale would be one-half, that of a globe representing Saturn on the same scale would be a little more than one-third, of the height of the Eiffel Tower.

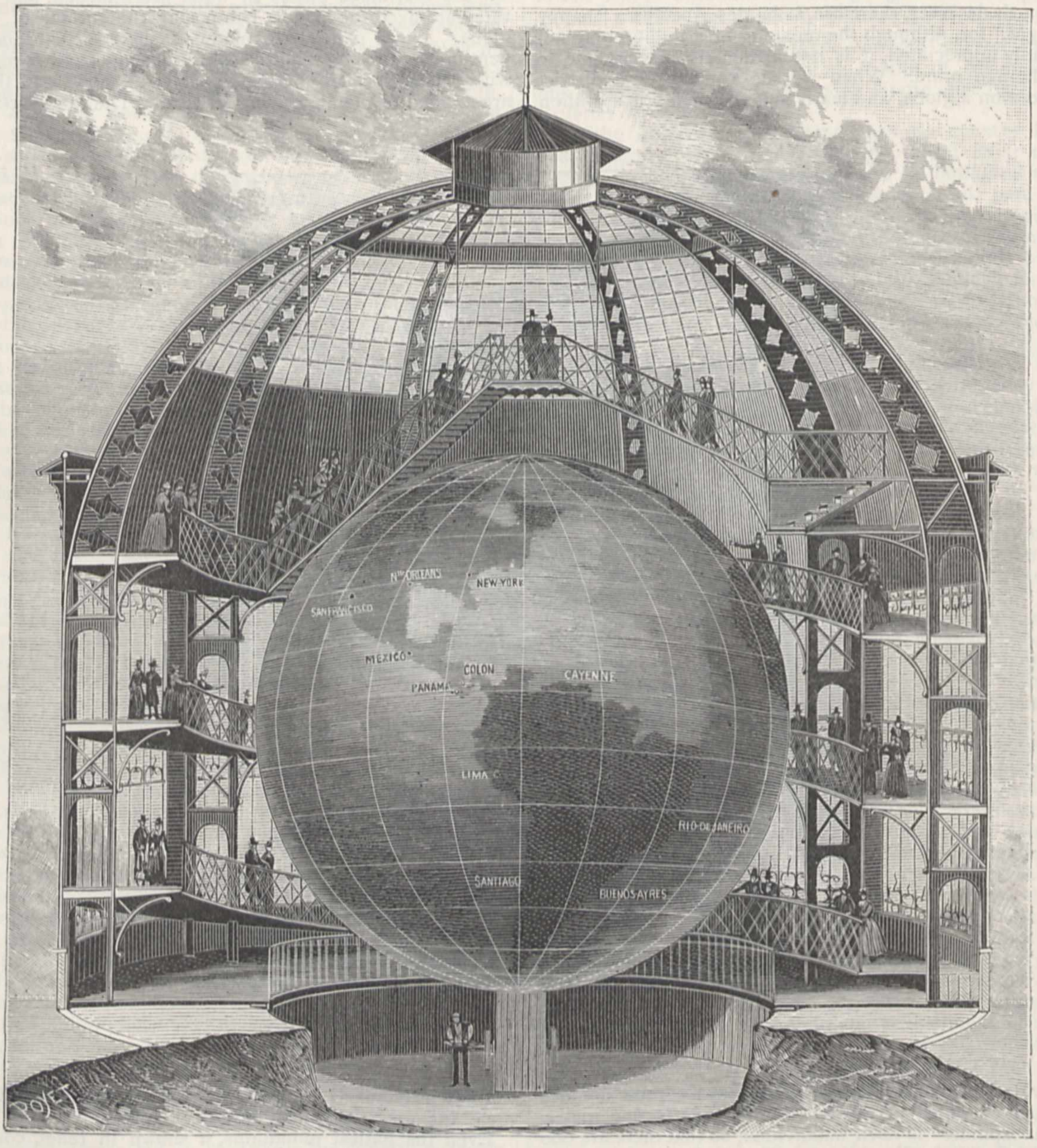


Fig. 2.

This is not the first occasion on which an attempt has been made to suggest by means of a great globe the size of the earth, and the extent of its oceans and land-masses. The globe of the Château of Marly, which is still to be seen in the National Library of Paris, excited much admiration in the age of Louis XIV., but it has only a diameter of about 5 metres, and is much less effective for its purpose than its successor in the Paris Exhibition.

It is significant of the present stage of our knowledge of the interior of Africa that the makers of the globe, in preparing their maps, had twice to alter their representation of that continent in order to indicate the results of the most recent geographical discoveries.

MARINE BIOLOGY IN THE UNITED STATES.

THERE has recently been issued the first Annual Report of the Marine Biological Laboratory at Wood's Holl, Mass. The Laboratory is an outgrowth of a smaller predecessor maintained at Annisquam, Mass., for six years, by the Woman's Education Association of Boston, in co-operation with the Boston Society of Natural History; and the locality where it is pitched is one which has been in especial favour with marine zoologists of the New World, from Alex. Agassiz downwards. The edifice is a small one (63 × 28 feet), two stories high, of plain but very substantial build. It has been especially designed for the purpose to which it is put, and there are eight private rooms available for the use of investigators. Conspicuous among the names of those chiefly concerned in its maintenance are those of persons known to be familiar with the workings of the leading biological laboratories abroad; and Dr. C. O. Whitman, of Milwaukee, has accepted the office of Honorary Director. It is thus manifest that, in the selection of those who are to control the working of their enterprise, the promoters have secured the services of those of their countrymen whose influence would be most conducive to a successful issue.

The Laboratory is regarded by the Director as a "first step towards the establishment of an ideal biological station, organized on a basis broad enough to represent all important features of the several types of laboratories hitherto known in Europe and America." In a very interesting opening address, the same gentleman lays it down as a tenet that "a biological station should be a purely scientific affair from beginning to end," and the spirit of his words appears to have entered into the very organization of the institution over which he presides. Competent investigators not requiring instruction are invited to carry on their researches free of charge, and a small fee is asked only of those whose work requires supervision; while, with a view to developing the resources of the country, provision is made for the conducting of short seven weeks' courses of instruction in marine zoology and microscopical technique. Arrangements are also to be made for the delivery of "occasional lectures, or informal accounts of results obtained in special lines of research carried on at the Laboratory."

The above-named short courses of instruction are no mere vacation ones, whereby the Laboratory would be in danger of conversion into a summer *rendezvous*, but recognized portions of a working scheme; and, in providing for them, our American brethren have taken a new and most important departure in the advance of biological education, and one upon which we ourselves might well act. To many of us it has long been obvious that our own methods of teaching elementary biology are being overstrained. The type-system, in which we justly glory, is being pushed to an extreme not dreamt of by its founders; but while some such method must always be relied upon for a first beginning, we stand in need of a supplementary system, whereby there may be assured to the advanced student a field of labour less restricted than that now largely adopted. We would have him brought face to face with unfamiliar forms of life—forms of which he might probably never have heard—and left to himself (competent assistance being accessible in case of emergency) to identify and to determine them. The student is, at present, nurtured on too great a regard for authority; he is taught to rely too fully upon his teacher, and his powers of independent judgment become thereby stunted; and, unless some means be taken to dispel this delusion, the systematic work of even the near future must suffer. We are of opinion that the remedy is to be found in some such action as that instituted by the officers of the Wood's Holl Laboratory. We need more field-work, and the advanced student should be compelled to supplement the special training which he now receives with, say, a two to three months' course at the sea-side. Many of our existing schools are already located in situations favourable to the requirements of the case, but their movements are so hampered by the demands of the narrow "syllabus" that little opportunity is left them for the development of their special resources. Setting these institutions aside, however, we believe that access to a fully equipped laboratory is not a *sine quâ non* for the fulfilment of that which we desire. It is true that "any enthusiastic young person who may unfold his umbrella on the sea-shore" cannot be said to have "opened a zoological station"; but it is none the less certain that a born biologist will pursue his calling even under a sunshade, and it should be one of the highest aims of our educational system to single him out. To this end, let the student found his own laboratory in a convenient room in some good locality; set him to collect, to identify, and to preserve; let him rely upon his ingenuity for the construction and arrangement of his accessories; give him ample opportunity to make the most of the resources of the surface-net; and leave the rest to nature. The student who, granted a previous sound elementary training, free of bias, would most readily rise to the emergencies of the case we picture, would be he to whom we would most confidently intrust the future development of our science; and it cannot be denied that our existing methods of training fall short as a sure means of securing him.

Our American brethren are content with humble beginnings. Their Laboratory is small, but it is managed as such an institution should be. We believe our dream to be indicative of a general want; and, should its realization ever come about, to the women of the United States will be due the honour of having inaugurated a recognized system of training such as, to us, seems most desirable for its attainment. Better this than empty glory in a costly edifice.

Young as is the Wood's Holl Laboratory, a record is published, without ostentation, of work commenced in five definite subjects, and efforts are being made to establish a scholarship fund in connection with the institution. The citizens of the United States are now striving by private enterprise to do, for the pure science of aquatic biology, that which their legislators have so nobly done for the fish industries. We heartily wish them success. G. B. H.

NOTES.

THE next International Archæological Congress is to be held in Christiania in 1891. It was originally intended that it should be held in London. Dr. Ingvald Undseth, of Christiania, is the General Secretary.

MORE than 500 members will take part in the forthcoming Oriental Congress in Stockholm, among them being official delegates from Egypt, Persia, India, Siam, China, and Japan. Two famous Arabic scholars of Medina—Mahomed Mahmud and Mahomed Chingîtbî—will also be present.

THE programme of the second summer meeting of University Extension students and others, to be held in Oxford next month, is now published. The programme, as compared with last year's, shows one remarkable difference. The summer meeting of this year is to be divided into two parts, the first of which, lasting from Tuesday, July 30, to Friday, August 9, reproduces the main features of the meeting of last year—meetings, *conversaziones*, excursions, lectures and visits to libraries, museums, and so forth. On the list of lecturers appear the names of Prof. Max Müller, Sir Robert Ball, Mr. Herkomer, Mr. Lewis Morris, Prof. Henry Morley, Mr. W. J. Courthope, Mrs. Fawcett, Prof. Thorold Rogers, Prof. Pritchard, Prof. A. H. Green, Prof. S. R. Gardiner, Mr. Arthur Sidgwick, Mr. R. G. Moulton, and many others. The second part of the meeting, which is the special feature and new departure of this year, is to begin on Saturday morning, August 10, and end on Friday evening, August 30. This is intended to be a period of more serious and sustained study and instruction for those whose leisure and industry have not been exhausted during the previous ten days, as well as for those who may prefer three weeks of more quiet and systematic reading and lecturing. The lectures in this second part are arranged in connection with lectures of a more general character delivered in the first part. It is estimated that the total expense of attending the first part of the meeting need not exceed £5 for each person (including railway fare and price of ticket), and may be considerably less if several persons live together; while £10, it is estimated, may cover the expense of attending both parts of the meeting. The Secretary is Mr. W. A. S. Hewins, 35 Cornmarket Street, Oxford. The number of tickets is limited to 1200, of which about five-sixths have been already applied for.

Sir Edward Watkin was the client for whom Mr. Perks bought the summit of Snowdon at Tokenhouse Yard last week. It is said that Sir Edward has intimated his intention of offering a site on the summit to the Royal Astronomical Society for purposes of an observatory similar to that on Ben Nevis.

On Monday a deep-sea exploration party started from Kiel, on board the steamer *National*, for the Greenland coast, where they propose to carry on a series of submarine soundings and investigations. The expedition is directed by Prof. Hensen.

According to the *Times of India*, Mr. Oldham, of the Geological Survey of India, who is at Simla at present, is to be deputed to Mergui, in Burmah, on geological work.

Mr. Elliot, head of the Meteorological Department, has, according to the *Times of India*, reached Simla after a long and useful tour. He has arranged for the publication of a map of Bombay, showing the daily state of the weather on the coast, similar to that issued in Calcutta.

The vexed and protracted question of a good zoological collection for Bombay is, after years of discussion, at last on the point of being settled. It came to the ears of the Governor, Lord Reay, that the terms on which the Victoria Gardens are held by the Municipality of Bombay were at the bottom of the whole difficulty. No charge for admission could be levied at any time without the express consent of the Government. But without the aid of fees it would be impossible to maintain, much less to establish, a really good collection. The Government thereupon intimated their willingness to see a moderate fee charged for admission on certain days in the week, and on June 17 the matter was brought before the Corporation, and the proposals of the Municipal Commissioner were accepted. Curiously enough, the *Times of India*, which brings this information, also contains a letter from Mr. H. B. Brady, F.R.S., from London, describing the present zoological collection of Bombay as "a few poor beasts wretchedly housed." But now that fees can be charged at the Victoria Gardens, the situation is entirely changed, and there is no reason why the Bombay zoological collection should not speedily equal the fine collection at Calcutta.

Dr. Francis Day died on July 10 at his residence, Kenilworth House, Cheltenham. He was appointed to the Madras Establishment in 1852, and after taking part in the military operations then in progress at Burmah, for which he received the medal, he devoted himself exclusively to the study of fishes, and became Inspector-General of Fisheries in India. The results of his labours he presented in reports to the Government of India of 1865 to 1877, in numerous papers to scientific journals, and in the following general publications:—"The Fishes of Malabar," 1865; "The Fishes of India," 1868; "The Fishes of the Andaman and Nicobar Islands," &c., 1870; "The Fresh-water Fish and Fisheries of India and Burmah," 1873; "The Fishes of India," second edition, 1875-79; and "The Fishes of the Nilghiri Hills and the Wynaad," 1876. The Imperial Museum at Calcutta possesses his type collection of Indian fishes; and collections formed by him are in the Natural History Museums at Leyden, Berlin, Florence, and Sydney, and in the British Museum, to which he also sent his collection of Indian crabs. Dr. Day retired from the Madras Medical Staff in 1877. He then began the study of the fishes and fisheries of the United Kingdom, and in 1880-83 published "The Fishes of Great Britain and Ireland." He was created a Companion of the Order of the Indian Empire in 1885, and about the same time received the cross of the Order of the Crown of Italy.

According to the *Colonies and India*, the Dunedin Acclimatization Society have solved one of the greatest problems in connection with the acclimatization of salmon. They have procured ova from fish reared from ova sent from this country. It is claimed that this has never before been done in any part of the world.

In connection with a note by M. Leroy, in the *Comptes rendus* of June 17, M. Landerer pointed out, in a note read at the meeting of the Paris Academy of Sciences on July 8, that he was the first to describe the phenomenon of the decomposition of the image of the horizontal lines seen with the eye which remains closed during microscopic observations. M. Landerer offered two remarks in addition to his former statements: (1) although the effort made by the eye in microscopic vision appears to be of the same nature as the effort demanded by telescopic vision, the trouble caused to the closed eye is much more sensible in the former case than in the latter, no matter what the telescopic object may be. (2) The disposition which must be given to the eyes during microscopic vision involves the crossing of their optical axes, producing an effect like that of "strabism." This is proved by the fact that, in giving them this disposition, and then applying the eye to the ocular, one perceives the image distinctly. It is this simultaneous work of the two eyes that explains the trouble experienced by the eye which does not take part directly in the act of vision.

The Reale Istituto Lombardo proposes as subject for the Cagnola Prize (2500 lire, and medal 500 lire) in 1889-90 ("ordinary" competition) the following:—Investigation of one of the (at present few) trisubstituted derivatives of benzol; their mutual relations, and relations to the bisubstituted derivatives to be studied, and facts ascertained which will throw light on the laws of their properties and constitution. Samples of new bodies to be furnished. The date is April 30, 1890. For the "extraordinary" competition (same value of prize), a physico-physiological monograph on one of the larger Lombardy lakes is invited. The research must be carried out according to the directions published by Prof. Forel, of Lausanne, in 1887 Date May 1, 1890. Thirdly, a similar prize is offered for discoveries on the cure of pellagra; or the nature of miasma and contagion; or the steering of balloons; or means of preventing the falsification of writing. Date December 31, 1889. Manuscripts (in French, Italian, or Latin) are to be sent, with sealed letter, to the Secretary of the Institute in Milan.

The Transvaal Volksraad is reported to have placed £20,000 on the estimates for the current year, for the purpose of endowing the first University of the Republic.

According to the Calcutta Correspondent of the *Times*, a herd of 100 wild elephants has been captured in Mysore by

Superintendent Sanderson. The same correspondent states that there were 6000 deaths by snake-bites in the North-West Provinces last year. In Madras, 10,096 cattle were killed by wild animals, and the loss of human life by snakes and wild animals was 1642.

IN a telegram from Tashkend, dated July 12, it is stated that a shock of earthquake had occurred at Djarkend, in the Government of Semiretchinsk, by which half the town was destroyed.

PROF. W. FÖRSTER, Director of the Berlin Observatory, states in the *Reichsanzeiger* that shortly before midnight on the 11th inst., undulatory motions were observed in two water balances pointing north and south in the Berlin Observatory. These motions, he believes, were a distant effect of the earthquake near Tashkend. Similar motions were observed in Berlin, Breslau, and Königsberg on August 2, 1885, and it is concluded that they were caused by an earthquake which, as was afterwards found, had taken place at Tashkend half an hour earlier.

A SLIGHT shock of earthquake was felt at Charleston, U.S.A., at 9 47 on the evening of July 11. The disturbance lasted three seconds, and was accompanied by slight subterranean rumblings. The direction was from north to south.

AT a recent meeting of the German Meteorological Society in Berlin, Dr. Lang, of Munich, read a paper on the velocity of propagation of thunderstorms in South Germany in the ten years 1879–88. This is, on an average, 38·4 kilometres per hour; but it has varied considerably from year to year, increasing in the years to 1884, and thereafter decreasing. To this corresponds a curious variation of van Bebber's fourth and fifth depression-paths: which lay in the north at the beginning of the period, then moved south to South Germany till 1884, after which they retired northwards. Hail frequency has varied in an opposite sense to the velocity; but the rapidly moving winter thunderstorms have most hail. The velocity is maximum in winter; it falls rapidly till May, slowly rising thereafter (with a second depression in September) till winter. The velocity is greatest in storms coming from the west. Dividing the region into four zones from north to south, there is a decrease in the velocity, at first slight, but getting very rapid on reaching the Alpine region. The velocity is greatest about midnight, least about midday. At the same meeting, thunderstorms and hail in Bavaria in 1880–88 were the subject of a paper by Dr. Horn. These phenomena in general correspond; both have a maximum early in July, but the hail has a second maximum, nearly as great, in May. Both phenomena show a pronounced day maximum about 3 to 4 (in winter about 2 to 3), and a minimum in the morning from 7 to 8. Dr. Horn said hail never fell in Bavaria without electric discharge, but Dr. Assmann maintained it did sometimes in Prussia.

WE have received from Mr. A. L. Rotch the observations made at the Blue Hill Meteorological Observatory in the year 1887. This Observatory, which was established in 1885, is now one of the best-equipped stations in the United States; it is situated in Norfolk County, Massachusetts, about 635 feet above the level of the sea, being the highest point within ten miles of the Atlantic coast from Maine to Florida, and commands an unbroken view of the horizon in every direction. The value of the station has been recognized by the Harvard College, and the present volume appears as vol. xx. Part 1, of the Annals of the Astronomical Observatory of that institution, which is about twelve miles distant. Arrangements have been made for the continuation of this new form of publication, and the ultimate consolidation of the two institutions is contemplated—a step that will insure a more complete discussion of the observations than has been possible hitherto. In addition to monthly summaries, the present volume contains hourly values of all the principal elements. The hourly observations of rainfall, cloud, (7h. a.m. to 11h. p.m.), and sunshine are especially valuable. The sunshine observations are given in a novel and convenient form, showing the amount, in tenths, for each hour. The appendixes contain interesting discussions on thermometer screens, and on the differences of temperature between the base and the summit, as well as tracings from the self-recording instruments illustrating special meteorological phenomena. We congratulate Mr. Rotch and his staff on the completeness of their valuable work.

AMONGST the many beneficial measures which have taken place in Mexico, during President Diaz's four years' administration, Sir Francis Denys, of the British Legation, Mexico, in his last report, mentions those for the study and preservation of ancient monuments and historical remains. An inspector has been appointed, the building for the National Museum improved, and various collections relating to natural history, as well as to archæology, have been added. An archæological map of the Republic has been made, and plans and photographs of the palaces of Mitla have been obtained. Explorations of the ruins of Xochicalco, and of the pyramids of Teotihuacan have been undertaken, many interesting discoveries rewarding the explorers of the latter. A wall, 360 metres long, 3 metres high, and 1 metre broad, has been constructed around the palaces of Mitla for the protection of these gigantic monuments. The Republic now possesses a fine public library, where ancient documents and a large collection of scientific and historical works are at the disposal of the student.

ABOUT fifty objects of various kinds from the early Iron Age—swords, axes, arrow-heads, &c.—have lately been excavated from a barrow at Hvideseid, in South-Eastern Norway.

AN ancient canoe, hollowed by fire from the trunk of a tree, has been discovered in a moss at Thorsager ("Thor's Field") in Jutland, 4 feet below the surface.

IN the Report, just issued, of the trustees of the South African Museum for the year 1888, reference is made to the unwelcome appearance in some number, in the entomological collections, of a pest very prevalent in Europe and elsewhere, but hitherto of comparatively rare occurrence in South Africa, viz. the minute neuropterous insects belonging to the genus *Psocus*, and commonly known to collectors as "mites." It is not improbable that the unusually wet weather of the latter half of the year favoured the multiplication of these destructive insects. Naphthaline has been found very serviceable as a check to their attacks.

WE notice the appearance of the second volume of the "Ornitographia Rossica," by Th. Pleske, published by the Russian Academy of Sciences. It contains a description of the *Sylviæ* of the Russian Empire. A new edition of N. Kaufman's "Flora of the Government of Moscow," has also been issued. This remarkable work, which is regarded as classical by Russian botanists, was out of print. It has been thoroughly revised, and may be considered the most trustworthy source of information as to the flora of Moscow and the central plateau of Russia.

THE third volume of the "Ethnography of the Caucasus," now being published at Tiflis, contains the researches of Baron Uslar relating to the Avarian language. This language is spread in Daghestan, over a territory which crosses the highlands from north to south, and separates the eastern group of the Daghestan languages from the western. It is used by most tribes of the highlands in their mutual relations. Although possessing in its alphabet a great number of consonants hardly distinguishable from one another by the untrained ear, it is said to be very agreeable on account of the excellent proportions between the consonants and the vowels in its words.

A FULL bibliography of Russian books and papers on mathematics and physical sciences since the earliest days of printing is being published at Moscow, by V. V. Bobynin. The first instalment of the second volume brings the work down to the year 1774.

IN the new number of *Harvard College Bulletin* Mr. W. H. Tillinghurst has the following note:—"It is believed that M. Chevreul reached a greater age than any other person who had received a degree from Harvard College, outliving by a year Judge Timothy Farrar (1767), born July 11, 1747, died February 21, 1849, at the age of 101 years, 7 months, 10 days, who received the degree of LL.D. in 1847 on the completion of his one hundredth year. Two graduates of American Colleges have outlived M. Chevreul. Rev. John Sawyer (Dartmouth, 1785), was born October 9, 1755, and died October 14, 1858, aged 103 years, 5 days. He received the degree of D.D. from Dartmouth in 1857, when 102 years of age. But the oldest College graduate in this country known to the writer was Nathan Birdseye (Yale, 1736), who was born August 19, 1714, and died January 28, 1818, aged 103 years, 5 months, 9 days."

SOME interesting facts concerning the "element" tellurium have been brought to light by Dr. Brauner, of Prague, during the course of a series of atomic weight determinations, an account of which is given in the July number of the Journal of the Chemical Society. A determination of the atomic weight of tellurium made by Berzelius in 1832 yielded the number 128·3, and a later one in 1857, by von Hauer, gave the value 127·9. Hence 128 has usually been accepted as the true atomic weight. The properties of tellurium, however, indicate that it belongs to the sulphur group of elements, and that its position in the periodic system lies between that of antimony, of atomic weight 120, and iodine, of atomic weight 127. But according to the above determinations the atomic weight of tellurium is higher than that of iodine. Hence we are obliged to admit one of two things: either that the atomic weight of pure elementary tellurium has been incorrectly determined, or that the periodic law of the elements, that grand natural generalization whose distinguished elaborator English chemists have recently been delighting to honour, breaks down in this particular case. In view of the overwhelming mass of experimental evidence which has now accumulated in support of this generalization, the latter assumption cannot for a moment be tolerated. The redetermination of Dr. Brauner becomes therefore of primary importance, and his results partake of the highest interest. The mode of procedure which afforded the most satisfactory results consisted in the analysis of tellurium tetrabromide, $TeBr_4$, purified in the most complete manner, by means of silver nitrate prepared from pure silver. The mean atomic weight from these experiments was found to be 127·61, the maximum being 127·63, and the minimum 127·59. Hence there can no longer be any doubt that the substance we term tellurium does possess a combining weight larger than that of iodine. Now comes the question: Is this substance pure elementary tellurium? If it is, then, as Dr. Brauner says, it is "the first element the properties of which are *not* a function of its atomic weight." Dr. Brauner, however, finds as the result of a process of fractionation that it is not pure tellurium, and that it consists of probably three elements, pure tellurium mixed with smaller quantities of two other elements of higher atomic weights; and he is at present engaged in studying the nature of these foreign substances, and in the endeavour to isolate pure tellurium itself. A few of the as yet unpublished results obtained in these latter researches were communicated personally by Dr. Brauner at the meeting of the Chemical Society on June 6, and among them the interesting fact was stated that one of the new elements is probably identical with Prof. Mendeleeff's recently predicted dwitellurium, of atomic weight 214, the other new constituent being an element closely allied to arsenic and antimony.

THE additions to the Zoological Society's Gardens during the past week include a Poë Honey-eater (*Prosthemadera novæ-zealandiæ*) from New Zealand, presented by Mr. Alfred M. Simon; two Razorbills (*Alca torda*), two Guillemots (*Lomvia troile*), British, presented by Mr. W. B. Roberts; a White-throated Monitor (*Varanus albogularis*) from South Africa, presented by Mr. H. L. Jones; a Macaque Monkey (*Macacus cynomolgus*) from India, two Argus Pheasants (*Argus giganteus* ♂ ♀) from Malacca, a Military Macaw (*Ara militaris*) from South America, deposited; an Indian Coucal (*Centropus rufipennis*) from India, two Diamond Snakes (*Morelia spilotes*) from New South Wales, received in exchange.

OUR ASTRONOMICAL COLUMN.

COMET 1889 *d* (BROOKS, JULY 6).—The comet reported in NATURE of July 11 (p. 255) as having been discovered by Swift on July 5 appears to have been an observation of Barnard's comet of 1888 September 2, there having been an error in the transmitted position. The position should have been:—

R.A. 21h. 24m. 20s. N.P.D. 89° 11'.

A faint comet was discovered by Brooks on July 6.

July 6·790 G.M.T.; R.A. 23h. 44m. 8s.; N.P.D. 99° 9'. A rough approximation by Brooks.

July 8·9561 G.M.T.; R.A. 23° 46' 26"; N.P.D. 98° 55' 57". Observation by Barnard. Comet, slightly elongated, 1' in diameter, 11 mag. or fainter.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 JULY 21–27.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 21

Sun rises, 4h. 10m.; souths, 12h. 6m. 8·4s.; daily increase of southing, 2·8s.; sets, 20h. 1m.: right asc. on meridian, 8h. 3·9m.; decl. 20° 24' N. Sidereal Time at Sunset, 16h. 0m.

Moon (two days after Last Quarter) rises, 23h. 54m.*; souths, 7h. 0m.; sets, 14h. 19m.: right asc. on meridian, 2h. 56·6m.; decl. 12° 12' N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° '
Mercury..	2 42 ...	10 51 ...	19 0 ...	6 49·0 ...	22 23 N.
Venus.....	1 4 ...	8 53 ...	16 42 ...	4 49·9 ...	19 22 N.
Mars......	3 13 ...	11 25 ...	19 39 ...	7 23·5 ...	23 0 N.
Jupiter....	18 7 ...	22 1 ...	1 55*...	18 0·9 ...	23 21 S.
Saturn....	6 9 ...	13 35 ...	21 1 ...	9 33·3 ...	15 43 N.
Uranus...	11 39 ...	17 9 ...	22 39 ...	13 8·0 ...	6 34 S.
Neptune..	0 23 ...	8 12 ..	16 1 ...	4 9·1 ...	19 22 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° '		h. m.	
δ Libræ	14 55·1 ...	8 5 S. ...	July 25,	2 57	*m*
U Coronæ	15 13·7 ...	32 3 N. ...	,, 27,	2 38	*m*
U Herculis	16 20·9 ...	19 9 N. ...	,, 22,		*m*
U Ophiuchi	17 10·9 ...	1 20 N. ...	,, 23,	22 31	*m*
X Sagittarii... ...	17 40·6 ..	27 47 S. ...	,, 21,	23 0	*M*
W Sagittarii ...	17 57·9 ...	29 35 S. ...	,, 23,	23 0	*M*
U Sagittarii... ...	18 25·6 ...	19 12 S. ...	,, 26,	1 0	*m*
R Scuti	18 41·6 ...	5 50 S. ...	,, 23,		*M*
β Lyræ...	18 46·0 ...	33 14 N. ...	,, 24,	23 30	*M*
R Lyræ	18 52·0 ...	43 48 N. ...	,, 21,		*M*
U Aquilæ	19 23·4 ...	7 16 S. ...	,, 24,	21 0	*m*
η Aquilæ	19 46·8 ...	0 43 N. ...	,, 26,	23 0	*M*
S Delphini	20 38·0 ...	16 41 N. ...	,, 26,		*M*
X Cygni	20 39·1 ...	35 11 N. ...	,, 24,	2 0	*M*
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	,, 21,	23 0	*m*
δ Cephei	22 25·1 ...	57 51 N. ...	,, 23,	0 0	*m*

M signifies maximum; *m* minimum.

July.	h.	
23	21	Venus in conjunction with and 0° 41′ south of the Moon.
26	20	Mercury in conjunction with and 0° 19′ south of the Moon.
26	23	Mars in conjunction with and 0° 1′ south of the Moon.

Meteor-Showers.

	R.A.	Decl.	
Near γ Draconis	270	50 N.	Swift.
From Lacerta	335	50 N.	Swift.
	350	52 N.	Very swift.

BABYLONIAN ASTRONOMY.[1]

III.

WHEN names had to be given to stars, the Babylonians naturally took them from the objects around themselves. The heavenly host was compared to an immense flock, and several stars were grouped together to form the imaginary figure of either a bull, or a ram, or a goat, &c. It is too often taken for granted that the constellations have received certain names, and that the march of the sun through these signs has given birth to various legends, but those who see everywhere solar myths do not say why the constellations were so named. The names given to them must have some connection with what took place at their appearance, mark the seasons, or indicate the work, agricultural or other, of the seasons. The stars of the ecliptic, placed on the path of the planets, were associated with the monthly motion of the moon, and divided accordingly into thirty groups. Each of these constellations was one of the houses of the moon, and marked in the sky the course followed by it in one day.

The constellations were but indirectly connected with the sun's journey through the ecliptic. The acronic, not the heliac, rising of the stars and signs was especially observed, for those which were shining all through the nights of a certain period were considered as the protecting gods of that period.

Many of the allegorical figures representing the constellations were engraved on the boundary stones as images of protecting divinities, and they show the process by which the Babylonian artists arrived at the creation of the composite animals that still adorn our celestial globes. For instance, the Goat coming after Aquarius was represented as coming out of the water, and the hind part of its body changed into that of a fish. Sometimes three or more constellations were combined to form one figure: the horse, the scorpion, and the bow gave birth to a Centaur, holding a bow, and having a scorpion's tail—our Sagittarius.

When the zodiac was borrowed from Babylonia by the Egyptians, they adopted these very un-Egyptian images. There is still some uncertainty as to the date at which the borrowing took place, for all the Egyptian zodiacal representations are posterior to Alexander, but the idea may have been imported about 1600 or 1500 B.C. The Egyptians did not borrow bodily, however, the Babylonian zodiac of thirty signs, but adapted it to their solar year, and according to their sun-worship ideas, so the thirty signs were reduced to twelve, and were connected with the sun's march through the ecliptic. The thirty-six decans were in the same way connected with the sun's march, and three given to every month or ecliptic constellation, one therefore marking the space covered by the sun in ten days.

All attempts made as yet to identify the Babylonian names of stars have failed, because there was no base or starting-point. But now, with the list of the thirty constellations answering to the thirty divisions of the sky, identification is practically easy. In this work we are also helped by the classifications made by the augurs of Babylon for omen-taking; for instance, the twelve stars of the south must be stars of the austral hemisphere. We must at the same time take into account any mention made of stars in the inscriptions, and not forget that the acronic rising was the one observed and noticed by the Babylonians. By this comparative method it can be determined, for instance, that the star *Sukudu* or *Kak-si-di* was Sirius, for we are told that it was one of the seven most brilliant stars, and a star of the south; as it does not appear in the list of the thirty groups of stars, marking the path of the moon, it must be at a certain distance from the ecliptic. In several inscriptions the appearance of this star is used to determine a date; it must therefore appear only for a very short period. This same star is also called "directing star," because connected with the beginning of the year.

By a similar process we can determine that the star *Su-gi* was Canopus; the star *Iku* (or *Dil-gan*), Fomalhaut; the star *Sib-zi-an-na*, α Centauri; the star *Id-khu*, Altair; &c.

The thirty constellations dividing the ecliptic are not, however, all exactly on this line; for instance, one of them is *Sar* or *Merodach* (Orion), another is "the Sceptre of Bel" (Procyon). Having once identified several of these thirty constellations or stars, it is easy to identify the others, as the list is given in the tablet according to their order. We are also helped in our work of identification by the Egyptian zodiac, and the names preserved by Ptolemy. In Egypt, Merodach has become Horus, and the "Sceptre of Bel" that of Osiris. In some cases we can even identify the name of a constellation, though we are not able to pronounce it on account of its being written with a group of ideograms.

The Babylonians often, in star nomenclature, confounded a star with the constellation it belonged to, and substituted for the name of a star that of the god associated with it. We must also take into account the two different points of view adopted by the Babylonian astronomers and their Egyptian imitators.

[1] Abstract of the third lecture delivered by Mr. G. Bertin, at the British Museum. Continued from p. 261.

SCIENTIFIC SERIALS.

Revue d'Anthropologie, troisième série, tome iv., troisième fasc. (Paris, 1889).—Examination of human bones found by M. Piette in the walled-in cave at Gourdon, by Dr. Hamy. The results of M. Piette's explorations, although of some interest, have not contributed very largely to our acquaintance with human fossil bones, owing to the fractured and mutilated condition of these finds, which, as is often the case in cave-deposits, were limited to cranial bones, the maxillaries, and one or two of the upper cervical vertebræ. The most perfect of these were found in the middle of the walled cave in *débris* of reindeer and other animal bones, together with carved reindeer horns, cut flints and stones, and numerous stone hatchets, chisels, scrapers, &c., these remains being similar to objects found in other prehistoric stations in the south of France belonging to the reindeer period in Central Europe. At a more remote part of the cave M. Piette discovered a deposit, containing implements of a more ancient type, intermingled with the bones of the mammoth and bear, as well as of the reindeer. The human lower-jaw, found here at a depth of 15 feet, has the special character of analogous cranial remains derived from the Naulette and Spy caves, and belonging to the most ancient type of primæval man, whom MM. De Quatrefages and Hamy include under the name of the Canstadt race.—On the gold of ancient Gaul, by M. Cartailhac. The writer gives a detailed account, with numerous illustrations, of the various gold ornaments found in France, and shows how numerous are the instances in which large and splendid treasures of older art have been irreparably lost in consequence of the finders having consigned them to the melting-pot of the local goldsmith, a practice which can only be stopped by an alteration in the state of the law regarding treasure-trove. The extreme beauty of some of the bracelets, necklets, &c., and the unique character of their ornamentation, are unsurpassed by other objects of the same kind found in different parts of Europe.—Notes on the colour of the eyes and hair in Norway, by Drs. Abbo and Faye, with tables and annotations, by M. Topinard. From these reports it appears that the population of Norway exhibits a higher percentage (97·25) of light eyes than any other country in Europe. Flaxen hair occurs in 57·5 per cent. of the people of the northern provinces, and while absolutely black hair is found only in the ratio of 2 per cent., red hair does not rise higher than 1·5 per cent. in the scale of hair-coloration.—Kashgaria, by Dr. Seeland. In this notice the writer records the incidents of his journey from Kashgar to Ak-Sou, over a distance of more than 350 miles along the sandy ill-kept track that constitutes the principal military Chinese post road. The narrative lacks the interest of the previous numbers already referred to in this journal.—On the cephalic index of the Provençal population, by M. Fallot, with tables referring to the several departments, which give the varying maxima and minima in accordance with special cranial types.—Hallstatt in Austria, its places of burial, and its civilization, by Dr. Hornes. This is an extremely interesting summary of the important discoveries made within the last few years in the Hallstattian burying-grounds of Slavonian Austria, more especially at Watsch in Carniola, where the beauty and finish of the carved baldrics and belts have led contemporary palæontologists to regard them as an evidence of the existence in Central Europe of an early civilization which had already attained to considerable artistic culture before its extinction under the weight of advancing hordes of barbarian invaders. The necropolis of Hallstatt, for our acquaintance with which we are indebted to Baron Sacken, still remains unrivalled for the splendour and variety of its antiquities, notwithstanding the marvellous results of the recent Carniolian and Croatian finds. Between 1846 and 1863, Sacken and Ramsäuer published reports of their explorations of nearly 1000 tombs; while since that period the number of graves explored has risen to nearly 1900. Both at Hallstatt and Watsch the rites of interment and incineration had been followed with nearly equal frequency, but although in the case of the latter the graves appear to have been most richly supplied with gold ornaments and carved bronze arms, the abundance of yellow amber, and of decorative objects of the toilet which are found buried with the unburnt skeletons render it difficult to decide which of the two methods of disposing of the dead was regarded as the more distinguished. The cranial type is generally dolichocephalous, with a retreating forehead and long slightly prognathic face, resembling what is known in Germany as the "Reihengräbertypus." According to Sacken, the necropolis of Hallstatt dates from the third or fourth century B.C., revealing the presence in those regions of the Eastern Alps of the so-called Galli Faurisci, who prior to the Roman domination must have been familiar with an advanced stage of civilization and decorative art, in which the influence of Greek art is undeniable. This is indeed strongly manifested both in the workmanship and the forms of multitudinous objects revealed by the exploration not merely of the Hallstattian tombs, but of the prehistoric station of Salzberg, whose discovery last year has added new interest to the still contested problem of the origin of the early culture of the Alpine races of Central Europe.

Rivista Scientifico-Industriale, May 15.—On sand showers, by Prof. P. Francesco Denza. His protracted observation of this meteoric phenomenon leads the author to infer that it is not sporadic, as is commonly supposed, but periodical, though subject to occasional disturbances. Its recent reappearance in several parts of Italy, after a considerable interruption, confirms the opinion already advanced by him, that the sands have their origin in the North African deserts, whence they are borne by the high southern gales as far as, and occasionally even beyond, the Alps. About the beginning of May atmospheric waves of low pressure advanced from West Africa across the Mediterranean to South-West Europe, causing a heavy rainfall as far north as the British Isles. In Sicily and Piedmont the showers were mixed with sands, while elsewhere the foliage was covered with a perceptible layer of dust. On May 12 a violent sandstorm raged in the North Sahara, as announced by telegrams from Biskra (Algeria), and this was soon followed by fresh downpours and by another shower of sand in North Italy far more intense than the first. In many parts of the Ligurian Alps and of Lombardy not only the vegetation, but the roofs of houses, terraces, marble monuments (in Turin and Milan), were strewn with fine particles, specimens of which were collected in various districts. The coincidence of the African simoom and the Mediterranean scirocco charged with sand leaves no doubt as to the real origin of the phenomenon popularly attributed to the effects of the April *luna rossa* ("red moon"). Prof. Denza's interesting communication is dated from the Observatory of Moncalieri (Piedmont), May 18, 1889.

Bulletin de l'Académie Royale de Belgique, May.—On a new method of testing for bromine, by Frédéric Swarts. This method, which yields excellent results, is based on the well-known fact that resorcinic phtalin (fluorescin) is transformed to its tetra-bromuretted derivative (eosine) characterized by a beautiful pink colour. The reaction consists in liberating hydrobromic acid, which is immediately oxidized by the hypochlorous acid. The bromine thus obtained then acts on the fluorescin, converting it into eosine, which is transformed to a pink salt under the influence of a slight excess of alkali. This reaction is so sensitive that it succeeds with a tenth of a cubic centimetre of water containing a hundred thousandth of potassium bromide, a quantity corresponding to a thousandth of a milligramme of this salt. In the case of iodine, it detects the presence of bromine in sea-water without submitting it to any preliminary treatment.—G. Van der Mensbrugghe describes a curious experiment in capillary attraction, the explanation of which is reserved for a future communication. The subject has engaged this physicist's attention since the year 1883, when he announced a simple method of demonstrating the contractile force of fluids which cannot easily be reduced to thin seams (*lames*).

Das Wetter (Brunswick) for June contains an article, by Dr. B. Andries, on the cold period of May, which generally obtains about the 10th of that month; the 11th to 13th being known as the three "ice saints." There is no doubt that each year frosts occur in May, after several days of warm weather have led us to hope for continued increase of temperature. But the author shows, from long series of observations at Bremen and Paris, that the same thing occurs in April and June, and that the weather of May is more uniform than all the other months, except October, which exhibits the same regularity in decrease of temperature that May does in the increase of the same. The variability arises from the influence of cyclones advancing from the Atlantic. In the interior of the Continent, the temperature becomes more constant, as the influence of the ocean becomes less. Dr. R. Assmann (the editor of the journal) contributes an article on the microscopic observations on the structure of hoar-frost, &c., made on the Brocken and elsewhere. His observations seem to show that hoar-frost is not always crystalline, but that, if the temperature is only slightly below the freezing-point, the hoar-frost, or rime, is often composed of amorphous particles of ice. A third article, by an anonymous writer, deals with the winters of the south coast of the Crimea. The climate is far from unpleasant; in a normal year, a brilliant autumn follows a dry summer, and a soft air continues far into November. December is generally cold and wet, and January fine; hard frosts do not occur till February, and then the struggle between winter and spring lasts until April. An interesting phenological table is added, showing the different effects upon vegetation between a wet or dry November and December.

Bulletin de l'Académie des Sciences de St. Pétersbourg, nouvelle série, i. (xxxiii.), No. 1.—With this number the *Bulletin* begins a new series, printed in a handy octavo shape. —On the rattle-apparatus of *Crotalus durissus*, by A. Feoktistoff. —On a simplification of Wild's photometer, by H. Wild.—On the solution of mechanical problems resulting in hyperelliptic differential equations, by C. Charlier.—Entomological contributions, by A. Morawitz, being a description of two new Central Asian species of *Carabus* (*C. pupulus* and *C. eous*), and a detailed monograph of many species of the same genus.—On the embryology of *Pteromyzon fluviatilis*, by Ph. Owsjannikoff.—Researches relating to the basicity of antimonic acid, by F. Beilstein and O. Blaese.—On the preparation of rubidium, note by N. Beketoff. —On a new Central Asian Siluroid (*Exostoma oschanini*), by S. Herzenstein.—On the absence of the common squirrel in Caucasia, by E. Büchner. Although Pallas, Nordmann, and Ménétries mentioned the *Sciurus vulgaris* as occurring in the Caucasus, there is not the slightest mention of it in the descriptive parts of their works, nor any representative of it in Ménétries's otherwise remarkable collection, kept in full at the Academy. The common squirrel could not be discovered in the Caucasus by the late M. Bogdanoff, nor by MM. Rossikoff, Mlokossewicz and Ananoff, who searched for it for years. It may have been that Pallas, Nordmann, and Ménétries simply reported the words of the Caucasus Cossacks, who give the Russian name of *byelka*—usually applied to the squirrel—to *Myoxus glis*, which really appears in the Northern Caucasus. It is also worthy of note that the common squirrel does not appear in the Crimea.—Hydrological researches, by Carl Schmidt. Analyses of the thermal springs at Saniba, in the north of Mount Kazbek.—Analyses of the sulphate of aluminium, by Beilstein and Grosset.

SOCIETIES AND ACADEMIES.

London.

Entomological Society, July 3.—Lord Walsingham, F.R.S., President, in the chair.—A letter was read from Mr. E. J. Atkinson, Chairman of the Trustees of the Indian Museum, Calcutta, in which assistance was asked from British entomologists in working out various orders of Indian insects.—The following motion, which had previously been unanimously passed at the meeting of the Council, was read to the Society:—"That papers containing descriptions of isolated species widely remote in classification or distribution are, as a rule, undesirable for publication, as tending to create unnecessary difficulties for faunistic or monographic workers." Mr. McLachlan, Mr. Jacoby, Mr. Elwes, Dr. Sharp, and others took part in the discussion that followed.—Mr. McLachlan, on behalf of Prof. Klapálek, of Prague, who was present as a visitor, exhibited preparations representing the life-history of *Agriotypus armatus*, Walk., showing the curious appendages of the case. Prof. Klapálek, in answer to questions, described the transformations in detail. A discussion followed, in which Mr. McLachlan and Lord Walsingham took part.—Mr. H. J. Elwes exhibited a specimen of an undescribed *Chrysophanus*, taken in the Shan States, Upper Burmah, by Dr. Manders, which was very remarkable on account of the low elevation and latitude at which it was found; its only very near ally appeared to be *Polyommatus Li*, Oberthur, from Western Szechuen, but there was no species of the genus known in the Eastern Himalayas or anywhere in the Eastern tropics.—Mr. G. T. Porritt exhibited a remarkable series of *Arctia mendica*, L., bred from a small batch of eggs found on the same ground at Grimescar, Huddersfield, as the batch from which the series he had previously exhibited before the Society was bred. This year he had bred forty-five specimens, none of which were of the ordinary form of the species: as in the former case, the eggs were found perfectly wild, and the result this year was even more surprising than before.—Mr. R. W. Lloyd exhibited specimens of *Harpalus cupreus*, Steph., and *Cathormiocerus socius*, Boh., recently taken at Sandown, Isle of Wight.—Mr. O. E. Janson exhibited a fine male example of *Theodosia howitti*, Castelnau, a genus of *Cetoniidæ* resembling some of the *Dynastidæ* in the remarkable armature of the head and thorax. The specimen had recently been received from North-West Borneo.—Mr. W. White exhibited specimens of *Heterogynis paradoxa*, Ramb., and stated that this insect represented an extreme case of degeneration, the mature female being only slightly more developed than the larva, the prolegs being quite atrophied. Lord Walsingham made some remarks on the subject.—Mr. T. R. Billups exhibited a fine series of the very rare British beetle, *Medon* (*Lithocharis*) *piceus*, Kr., taken from a heap of weeds and vegetable refuse in the neighbourhood of Lewisham on May 19.—Mr. W. F. Kirby read a paper entitled "Descriptions of new species of Scoliides in the collection of the British Museum, with occasional reference to species already known."—Mr. J. B. Bridgman communicated a paper entitled "Further additions to the Rev. T. A. Marshall's Catalogue of British Ichneumonidæ."—Mr. J. S. Baly communicated a paper entitled "On new species of *Diabrotica* from South America."

Anthropological Institute, June 25.—Dr. John Beddoe, F.R.S., President, in the chair.—Prof. Victor Horsley exhibited some examples of pre-historic trephining and skull-boring from America.—His Excellency Governor Moloney, C.M.G., exhibited some cross-bows, long-bows, quivers, and other weapons of the Yorubas.—The Rev. Dr. Codrington read a paper on poisoned arrows, in which he stated that the natives relied upon the words of incantation used during the manufacture of the arrows much more than the toxical effect of any substance into which they might be dipped or which might be smeared upon them; indeed, that in many cases the so-called "poisoned arrows" were not poisoned at all.—A paper by Mr. Henry Balfour, on the structure and affinities of the composite bow, was read.

PARIS.

Academy of Sciences, July 8.—M. Des Cloizeaux, President, in the chair.—On two new mechanical appliances, by MM. G. Darboux and G. Kœnigs. The first of these apparatus has been devised for the purpose of describing a plane in space by means of jointed rods; the second supplies a representation of the movement of a solid body revolving freely round its centre of gravity. The principles are described on which both have been constructed.—On the relations between the fractures in the terrestrial crust of a given region, and the seismic movements of the same, by M. A. F. Noguès. The author's comparative study of earthquakes in various parts of the world has led him to detect certain relations between these disturbances and the breaks of continuity in the surface of the earth. In the present paper he shows that, in a given seismic region offering a complicated system of fractures and faults varying in direction, size, and depth, the underground convulsions are correlated with some one of these systems, and entirely independent of the others. His illustrations are drawn mainly from the seismic zone of Andalusia, extending from Seville to the frontier of Murcia.—Influence of temperature on the mechanical properties of iron and steel, by M. André Le Chatelier. In continuation of his previous paper on this subject, the author here gives the results in detail for iron and steel, which are shown to behave quite differently from other metals under like variations of temperature. Three chief phases are distinguished, ranging respectively from 15° to 80° C.; from 100° to about 240°; and from 240° upwards.—On the solubility of carbonic acid gas in chloroform, by M. Woukoloff. Continuing his researches on the law of solubility of the gases, the author here studies the conditions of the solution of carbonic acid in chloroform. With the data obtained he finds that at a temperature of 13° C. his solution does not conform strictly to Dalton's law, although the deviations are very slight, as was also shown to be the case for the bisulphide of carbon.—On the solidification of nitrous acid, by M. Fl. Birhans. In his attempts to solidify anhydrous nitric acid still containing small quantities of hyponitrous acid, the author found that it was necessary to operate at a temperature of from −52° to −54°, obtained by the evaporation of the methyl chloride by means of a current of dry air.—On the cobaltites of baryta, and on the existence of a dioxide of cobalt with acid properties, by M. G. Rousseau. The experiments here described demonstrate the existence of a cobaltous acid analogous to manganous acid, but weaker. The maximum of stability of the manganite of baryta appears to be situated in the neighbourhood of 1100° C. At lower or higher temperatures this compound becomes dissociated like the hydrocarburets heated to the point of decomposition.—On an oxybromide of copper analogous to atacamite, by M. Et. Brun. M. Berthelot has noticed that when a clear solution of cuprous chloride in cupric chloride is exposed to the air, a greenish precipitate of oxychloride is formed, which is "probably identical with atacamite." The same reaction is produced by substituting for the cuprous chloride as a solvent the ammonium, sodium, and potassium chlorides. From the last two is obtained a crystalline powder, yielding on analysis the numbers corresponding to the formula of atacamite: $CuCl, 3CuO, 4HO$. M. Brun's present researches aim at the production of an oxybromide of copper from the corresponding bromides. The substance thus obtained possesses a constitution analogous to atacamite, which it closely resembles in its properties and mode of formation.—On the disturbances of the vision consequent on microscopic observation, by M. J. J. Landerer.—The large bones of the anthropoid apes, by M. Etienne Rollet. Since his communication of December 10, 1888, the author has made fresh measurements on the complete skeletons of forty-two adult apes, the results of which are here given in detail. From a comparative study of these figures it appears that the gorilla and chimpanzee approach nearest to man, but in different degrees, the orang holding the third place. But great differences exist between the proportions of the human frame and those of all the bimanous apes.

BERLIN.

Physical Society, June 21.—Prof. Kundt, President, in the chair.—Dr. Fröhlich demonstrated experimentally his new method of recording vibrations in the form of curves; the method has been recently described verbally to the Society. Light from an electric arc-lamp was made to fall upon a small mirror, attached either to the vibrating plate of a telephone, or to a piece of card covered with a thin film of iron, or to a thin india-rubber membrane. From this mirror it was reflected on to a polygonal rotating mirror, and by this on to a transparent screen, being thus made visible to the whole audience either as a spot of light when the rotating mirror was at rest, or as a line of light when it was set in motion. On sounding various organ-pipes in front of the receiver of the telephone, many very pretty curves were seen; on singing the vowels into the telephone, very characteristic curves were seen crossing the screen; so also with the consonant *r*, whereas on the other hand *s* produced no effect. The next experiment consisted in connecting the rotation of the mirror with the interrupted electric current, whose action was under investigation, in such a way that the vibrations of the membrane produced by the current gave rise to persistent curves upon the screen. The current from a battery produced an interrupted sinuous line of light, in which e ch r se of the curve was somewhat slower than the steeper fall of the same. On introducing a coil into the circuit the curve showed no change as long as the telephone was in front of the coil; when it came behind the coil, the curve described was almost a sine-curve. On putting an electro-magnet into the circuit the amplitude of the curves was less; so also when self-induction existed in the circuit, while at the same time the rise and fall of each part of the curve was less steep. A condenser gave rise to a curve with very sharp-pointed sinuosities. An apparatus for producing alternating currents gave rise to a regular sine-curve, which was affected by a coil electro-magnet and condenser in the same way as was the curve due to a battery current. Lastly, experiments were made with an induction-coil. On placing the telephone in the primary circuit, the vibrations of its plate gave rise to uniform sine-waves, whose height was less when the telephone was introduced into the secondary circuit, while at the same time they showed a phasic difference of ¼ wave-length. This change of phase due to induction, as exhibited in most striking manner to the large assembled audience, can be recorded by photography of the curves and thus submitted to exact measurement.—Prof. Gad gave a short account of researches made, in conjunction with Dr. Heymans, on the effect of temperature upon muscular contraction. These are to be the subject of a more extended communication to the Physiological Society.

Physiological Society, June 28.—Prof. du Bois-Reymond, President, in the chair.—Prof. Gad gave an account of experiments which he had made, in conjunction with Dr. Heymans, on the influence of temperature upon the working-power of muscles. In accordance with Fick's procedure, the muscles were experimented upon not only in an isotonic condition, where there is no change of initial tension, and stimulation leads merely to a shortening of the muscle, but also in an isometric condition, where there can be no change of length in the muscle, and stimulation produces only a change of its tension. Various muscles from frogs were examined at temperatures of 36°, 30°, 13°, 5°, 0°, and − 5° C., being freely suspended in a metallic cylinder immersed in a water-bath. The muscles were stimulated electrically by maximal and super-maximal induction-shocks due to breaking the primary circuit, these being single or repeated or tetanizing. The curve of the isotonic muscle was symmetrical at 19° C.; at 5° C. it rose much more slowly, and was both higher and longer than at 19° C. At temperatures down to and below 0° C. the rise of the curve was still slower and its height less than at 5° C., but on the other hand its length was greater. At higher temperatures the height of contraction was greater than at 5° C., the duration less than at 19° C., and the curve of contraction was symmetrical. At still higher temperatures there was a very considerable fall in the height of contraction, and its duration was still shorter than before. Irritability disappears immediately before the occurrence of heat-rigor. The curves of a muscle in the isometric condition were an exact reversal of those for the isotonic: low and short at 40° C. to 36° C., they were longer and very high at 30° C. At 19° C. there was a very marked diminution in height, while the length was slightly greater; at 5° C. the curve was again higher than at 19° C. and much longer, and below 0° C. lower and longer. When stimulated by a tetanizing current the curve of the isotonic muscle was highest at 30° C., but fell very rapidly from this height, a sign of rapid exhaustion. At 19° C. the curve rose to a less height, and less precipitately, and fell quite suddenly on the cessation of the stimulus. At 5° C. the curve rose more gradually to a less height, and was prolonged considerably after the stimulus was removed, and this was also the case at temperatures below 5° C. The curve of tetanus for an isometric muscle was again, as in the case of single contractions, an exact reversal of that obtained from an isotonic muscle. When discussing the results of the above experiments, the author gave special prominence to the facts that the height of the curve of contraction is least at 19° C. (the temperature of the room) and is increased by either warming or cooling the muscle; further that the duration of the contraction, which is about 0·1–0·2 second at 19° C., increases rapidly as the temperature falls, and is as much as 2·6 seconds at − 5° C. In explanation of the first fact the author assumed that, in accordance with Fick's hypothesis, during the combustion of carbohydrates and fats to carbon-dioxide and water some intermediate product (? lactic acid) is formed, and acts as a stimulus: the various temperatures under which the muscle works must then be supposed to have varying influences upon the formation and subsequent final oxidation of this intermediate product.—Dr. Obermüller described a new reaction for cholesterin which he had discovered. It consists in treating cholesterin with propionic-anhydride; this leads to the formation of a compound of propionic acid and cholesterin, which on being fused and allowed to cool shows, even in minute traces of the substance, a fine play of colours from violet through blue and green to red. In the green stage the compound consists of minute spheroidal crystals, which are larger in the red stage, and show a black cross when examined between crossed Nicols.

VIENNA.

Imperial Academy of Sciences, April 11.—The following papers were read:—On the constitution of the quinine-alkaloids, by H. Skraup.—On some aldehyde-like products of the condensation of urea and their tests, by E. Luedy.—Remarks on the comet discovered by Barnard on March 31, by E. Weiss.—On the diffusion of bases and acids, by E. Stefan.—On desiccative oleic acids, by K. Hazura.—On oxidation of non-saturated fatty acids by potassium permanganate, by A. Gruessner and K. Hazura.—Contribution to the flora of the East (on the plants collected in 1885 in Pamphylia by Dr. Heider), by R. von Wettstein.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Matriculation Directory, No. 6, June 1889 (Clive).—A Text-book of General Therapeutics: W. Hale White (Macmillan).—Lord Howe Island, its Zoology, Geology, and Physical Characters (Sydney, Potter).—Fallow and Fodder Crops: J. Wrightson (Chapman and Hall).—The Fauna of British India, including Ceylon and Burma; Fishes, vol. i.: F. Day (Taylor and Francis).—Veröffentlichungen der Grossherzoglichen Sternwarte zu Karlsruhe, Drittes Heft: Dr. W. Valentiner (Karlsruhe).—Annalen der k. k. Universitäts-Sternwarte in Wien (Währing), v. and vi. Band (Williams and Norgate).—Ancient Art of the Province of Chiriqui, U.S. of Columbia; W. H. Holmes (Washington).—A Study of the Textile Art: W. H. Holmes (Washington).—The Cave Fauna of North America, with Remarks on the Anatomy of the Brain and Origin of the Blind Species (National Academy of Sciences, vol. iv., First Memoir).—Who are the American Indians: H. W. Henshaw (Washington).—Journal of Anatomy and Physiology, July (Williams and Norgate).

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