THURSDAY, MAY 29, 1890.

THE LABORATORY OF THE ROYAL COLLEGE OF PHYSICIANS, EDINBURGH.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Vol. II. (Edinburgh and London: Young J. Pentland, 1890.)

THE liberal spirit in which the laboratory of the Royal College of Physicians of Edinburgh is thrown open to workers in every department of biology that bears, however remotely, upon medicine is worthy of the highest praise. That the opportunity for research thus afforded has been appreciated is well shown by this record of the work done in the laboratory during the second year of its existence. Sixteen papers are included in the volume, many of them anatomical and gynæcological, some pathological, one morphological (on the stomach of the Narwhal), and others (while including the results of studies in the laboratory) in the main clinical. This very diversity renders criticism difficult. Taking a high critical standpoint and employing as a standard the volumes which emanate from laboratories devoted to one subject—the Reports of the Physiological Laboratory of University College, London, or the studies from the Biological Laboratories of Cambridge or of Owens College, for example—it would be easy to find fault, to indicate papers that ought scarcely to be included, and to discover the absence of any series of allied researches of high scientific value, such as might be expected to be turned out in some special field of work, were the laboratory already long established, and were it given up to one branch of science, rather than intended from the first to be of use for investigations in all branches of biology. Yet to judge the volume from such a standpoint would be unfair both to the promoters of the laboratory and to those working within it. Taking medicine alone—that is to say, as apart from surgery and gynæcology—its extent is so considerable, and the topics dealt with so varied, that all original investigations, even if of equally high practical value, cannot be of equal scientific import: when surgery and gynæcology are also included, it is yet more obvious that much of the work that is rightly performed in the laboratory, while capable of almost immediate application to clinical practice, will be of a nature that does not necessarily call for great powers of original research. Clinical importance equally with scientific value must determine the inclusion of articles in such a volume as this. Herein, indeed, lies the only valid criticism that can be directed against these reports: if they be published purely as evidence of the activity of the laboratory, they well fulfil their purpose; but it is a little difficult to see what other use they possess. From the very diversity of the investigations, the reports cannot be expected to rank as useful additions to the library of the specialist in any of the subjects treated; there is too much extraneous matter. The gynæcologist will reap little benefit from the latter half of the volume, the pathologist will fail to appreciate the niceties of frozen sections of the lower portion of the body, cut in different planes. If such reports are to be of value to other workers, rather than, as I have said, as evidence of activity, they must be issued in separate parts, and, what is of still greater importance, they must assuredly not be issued at regular intervals. Successful as the laboratory has been up to the present, it is impossible to manufacture always a definite quantity of original work per annum and to order, and if it is intended to publish so many hundred pages at the expiration of every year, then it is only to be expected that many of those pages will either be work not of the highest quality, or will be upon subjects incompletely matured.

Having said thus much, it is a pleasure to draw attention to the many excellent articles that appear in these reports. The investigation by Mr. Irvine and Mr. Woodhead (the late Director) upon the secretion of carbonate of lime, a continuation of that described in the last volume, is of great importance to morphologists as well as to pathologists. In their last paper these observers pointed out that birds can assimilate and secrete carbonate from other salts of lime, as, for instance, the sulphate, and they advanced the statement that coral animals have in all probability the same power. In this communication is described the process of shell formation in the crab. The crab can produce its shell if, in the artificial sea-water with which it is supplied, the chloride be the sole calcium salt present; and the carbonate which forms the basis of the shell is deposited, it would appear, by a process of dialysis within the chitinous upper part of the epithelial cells. In this process it is suggested that phosphoric acid acts as the carrier of the lime to parts where carbonic acid is being given off; that carbonate of lime is formed in such regions; and that the phosphoric acid re-enters the circulation. It is thus rendered easy to comprehend why it is that wherever dead or vitally inactive tissue exists in the body, in bone matrix, chitin, and foci of caseous or fatty degeneration, there lime is deposited.

It has been known since 1875 that glycosuria may be only apparent, and that the agent reducing oxide of copper in the presence of an alkali, after the administration of chloral hydrate, for example, is not a sugar. Schmiedeberg and Meyer, in 1879, showed that this substance is glycuronic acid. Dr. Ashdown contributes an excellent paper upon the differentiation of this substance from glucose. From his experiments he leans to the view that there is a distinct chemical process presided over by the renal epithelium, which has as its result the formation of glycuronic acid—morphia, chloroform, curare, or one of a number of other drugs, being present in the blood.

Mr. H. A. Thomson, in his paper upon "Tuberculosis of the Bones and Joints," gives what is perhaps the most complete *résumé* of the varieties of tubercular affection in these regions that has yet appeared in our language; following König, he emphasizes the bone-factor in joint tubercle, as opposed to the synovial membrane. Dr. Cartwright Wood's paper, upon "Enzyme Action in the Lower Organisms," deals in a most suggestive manner with certain points in the biology of the Bacteria. The action of the soluble ferments produced during the growth of micro-organisms, not only in directing and controlling the growth in various media, but, as each month at the present time is yielding further indications, in producing the symptoms of disease, is a subject which before all

others deserves the attention of the medical profession, and Dr. Wood's paper is of the greatest interest in this connection.

Of the gynæcological articles, undoubtedly the most important is that by Drs. Barbour and Webster, upon the "Anatomy of Advanced Pregnancy and of Labour." The opportunities afforded to these observers have fallen to no others either abroad or in this country, and they have employed them to the full. The illustrations to their paper, as indeed throughout the Reports, are excellent.

J. G. ADAMI.

ABSTRACT MECHANICS.

Leçons Synthétiques de Mécanique générale, servant d'Introduction au Cours de Mécanique Physique de la Faculté des Sciences de Paris. Par M. J. Boussinesq, Membre de l'Institut. Publiées par les soins de MM. Legay et Vigneron, Élèves de la Faculté. (Paris: Gauthier-Villars, 1889.)

THE following *Table des Matières* will serve to show the scope of this treatise:—

1e Leçon. But de la Mécanique physique. Notions cinématiques indispensables.

2e Leçon. Les deux principes fondamentaux de la Mécanique.

3e Leçon. Forme des équations du mouvement; ce qu'on entend en Mécanique par force, forces motrices, actions mutuelles, &c. Pesanteur.

4e Leçon. Énergie potentielle interne. Action moléculaire.

5e Leçon. Principes de la conservation des quantités de mouvement et de leurs moments, pour un système matériel indépendant ou sans relations extérieures.

6e Leçon. Principes des quantités de mouvement et des moments pour un système partiel; de leur application à la formation des équations de mouvement des corps.

7e Leçon. Idées générales sur les pressions.

8e Leçon. Raisons physiologiques et psychologiques des dénominations de forces, actions, tensions, &c., employées en Mécanique. Forces d'inertie et centrifuges.

9e Leçon. Principe des forces vives pour un système partiel. Travail des forces. Énergie interne.

10e Leçon. Suite de l'étude des forces vives et du travail; flux de chaleur; loi fondamentale de la Thermodynamique.

11e Leçon. Application du principe des forces vives aux mouvements visibles ou moyens locaux; rôles qu'y prennent le travail de déformation des pressions exercées sur les particules matérielles et l'énergie potentielle de pesanteur; &c.

Such is the interesting syllabus of the subjects lectured upon by the author; and it is melancholy to think what we have lost in the treatment and illustration of such a programme at the hands of Maxwell, as a sequel and amplification of his inimitable little "Matter and Motion."

But when we open these pages we find a great contrast before us, and a great disappointment. Hardly anything more is to be found here than the elementary *banalités* of pure mathematics, in the shape of the explanation of co-ordinates and their differential coefficients as employed in representing the motion of a particle, and thence of a rigid body considered as an aggregation of particles. There is no interesting illustration or application or even diagram; merely a sequence of simple formulas of pure mathematics, interspersed with some metaphysical speculation; it is the purest of mathematics even by the side of Lagrange's "Mécanique Analytique"; we are given plenty of Mathematics, but very little Mechanics. The words of the preface to the "Lectures in Natural Philosophy in the University of Oxford," A.D. 1700, by John Keill, Savilian Professor of Astronomy, appear to be applicable even at the present day: "Although nowadays the mechanical Philosophy is in great Repute, and in this Age has met with many who cultivate it, yet in most of the Writings of the Philosophers, there is scarce anything mechanical to be found besides the Name. Instead whereof, the Philosophers substitute the Figures, Ways, Pores, and Interstices of Corpuscules, which they never saw;" &c.

These "Leçons" are the first of a course of Physical Mechanics to be delivered at the Sorbonne, with the intention of solving the Universe; but so far the author does not appear in touch with the physical questions, and he derives his mechanical notions from words in preference to facts. No doubt this is an excellent discipline for some minds, but to the applied mathematician it is devoid of all flavour.

The note to p. 34 we have found the most interesting passage in the book, pointing out that g varies with the position of the sun and moon, but that the variation would be imperceptible but for the tides.

The French have the advantage of possessing the two words *poids* and *pesanteur*; much of our own dynamical confusion would be cleared up if we had a separate word equivalent to *pesanteur*, something like *gravity*, or *gravitation*, as proposed by Thomson.

The word *force vive* for mv^2 is still allowed to appear in these pages, in spite of all the recent efforts of Thomson and Tait, Maxwell and recent writers to banish it to oblivion; this is carrying reverence for Lagrange too far for modern progress.

Maxwell's "Matter and Motion" practically covers the same ground as these "Leçons," and the two books compared would offer the best idea of the difference between the teaching of abstract Mechanics in this country and in France.

A. G. G.

OUR BOOK SHELF.

A Manual of Anatomy for Senior Students. By Edmund Owen, M.B., F.R.C.S. (London: Longmans, Green, and Co., 1890.)

THIS manual has been written from a point of view different from that usually adopted in anatomical text-books. Instead of giving a detailed systematic or topographical description of the whole of the organs or parts of the body, the author has selected those regions or structures which have a special reference to medical and surgical practice, and he has described them as fully as is necessary to bring out the points which have to be considered and attended to by the practitioner. In making his selection, he has not limited himself to a description of those parts or arrangements which are characteristic of adult structure, but he has incorporated in his book an account of such developmental anomalies as are sometimes

observed in infancy and childhood, and regarding which anxious parents require the advice and assistance of the surgeon. But, although written by a surgeon, the manual is not confined to what is commonly called "surgical anatomy." The needs of the physician have been consulted, and the position and boundaries of the heart, the lungs, and the great viscera of the abdomen have been described and illustrated by appropriate diagrams. In many instances the author seeks to give an explanation of the symptoms produced by disease of the viscera by a reference to the anatomical relations and connections of the parts.

The marvellous progress which operative surgery has made of late years is illustrated by several chapters in this manual. The antiseptic system of treatment, devised by Sir Joseph Lister, has rendered possible the performance of many operations which would not have been thought of fifteen or twenty years ago. The brain, the spinal marrow, the great serous cavities of the body, and the larger joints, are now with safety made the subjects of operative interference. No treatise on applied anatomy therefore would now be considered complete unless it embraced an account of these parts in their surgical relations, and Mr. Owen has furnished his readers with the necessary information.

The mode of treatment necessitates on the part of the reader some preliminary knowledge, so that the book is not intended for the beginner, but for the senior student and the practitioner.

Advanced Physiography. By John Thornton, M.A. (London: Longmans, Green, and Co., 1890).

THIS is a continuation of the same author's "Elementary Physiography," and, to quote the preface, "It carries the student into the wider realms of Nature, and treats of advanced physiography as defined by the Science and Art Department. Whether physiography be regarded as a separate science or not, it cannot be denied that, as thus set forth, it includes a fairly well-defined and well-ordered series of facts connected with the study of the universe." This is, perhaps, the first really serious attempt which has yet been made to give anything like a full account of the whole subject, and we have no doubt that teachers will find it convenient to have all the parts thus brought together. The author has very wisely quoted the best authorities, a proceeding which is far preferable to mere paraphrase. The book is thus largely a compilation, but it is only fair to say that full acknowledgment is made in nearly every case.

Most of the important astronomical instruments are described in considerable detail, and the fundamental notions of astronomy are clearly explained. The chapters on the so-called "new astronomy" are exceptionally good for a work of this class, and it is quite evident that the author has carefully followed the latest researches. Vogel's work on the orbit of Algol and Schiaparelli's new rotation period for Mercury are included, though only recently published. There is also an excellent summary of the work which has been done in celestial photography. The chapter on the sun is very detailed, and considers all the important facts and theories. No attempt is made to discuss any disputed points—a commendable feature in a school text-book.

There are apparently few mistakes, but one is of sufficient importance to be referred to. On p. 249 it is stated that the dark bands in stars like α Herculis are probably due to carbon absorption; this ought to read metallic fluting absorption, the *bright* flutings being probably due to carbon.

The book is profusely illustrated, but most of the diagrams have already seen service. The drawing of the Orion nebula is perhaps the least satisfactory. The large coloured plate is instructive, but there is a curious mistake. This has probably arisen from the fact that the plate is compiled from those which have appeared in the last two editions of a well-known text-book of astronomy, one of which was on a scale of wave-lengths, and the other on a prismatic scale. The flutings of carbon have evidently been transferred from one to the other without the necessary corrections, the result being that they are quite out of place relatively to the other spectra.

We can confidently recommend the book to all interested in the subject, whether for examination purposes or for the purpose of acquiring fairly accurate information as to the present state of our knowledge of the Earth's place in Nature.

An International Idiom: a Manual of the Oregon Trade Language, or "Chinook Jargon." By Horatio Hale, M.A., F.R.S.C. (London: Whittaker and Co., 1890.)

IN the district formerly called Oregon, which is of much wider extent than the State of Oregon, a sort of international language, known as the Chinook jargon, is current among the native tribes and white traders. It grew up about the beginning of the present century, and has been of great service not only in facilitating commerce, but in stimulating friendly intercourse between tribes who, if this strange speech had not existed, would have had no means of communicating with one another. Many of the words are of Chinook origin, but contributions have also been drawn from French and English, and various words have been formed by onomatopœia. In 1841, when connected with the United States Exploring Expedition which surveyed a part of the western coast of North America, Mr. Hale had occasion to study the Chinook jargon; and he has since taken pains to make himself acquainted with information brought to light by later investigators. In the present little volume he gives a full account of the subject, describing the origin and history of the "idiom," and presenting a grammar and dictionary, with specimens of colloquial and narrative phrases, songs, hymns, and a sermon. The facts he has brought together are of considerable scientific interest, and the book ought to be useful to travellers and settlers in the North American Pacific States and Provinces.

A Class-book of Geography, Physical, Political, and Commercial, for Intermediate and Senior Pupils. By W. B. Irvine, B.A. (London: Relfe Brothers, 1890.)

THE compilation of this volume must have cost the author a good deal of hard work, but we cannot say that the result seems to us satisfactory. The subject is treated in an extremely uninteresting way, and the appearance of the pages, with their short, jerky paragraphs and masses of disconnected facts, might alone suffice to deter many boys and girls from the study of geography. In the teaching of this subject almost everything depends on the intelligence and skill of the teacher; so that even the present work, in good hands, might be made the basis of instructive and useful lessons. But the book would increase rather than diminish the difficulties in the way of teachers who have no exceptional degree of ability or knowledge.

LETTERS TO THE EDITOR.

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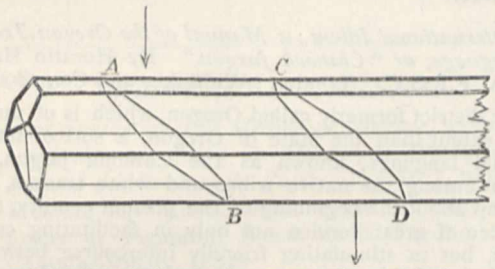
Idiocyclophanous Crystals of Calcite.

IT seems to have escaped notice that one at least of the many crystal-forms of calcite can be induced to show its ring-system—can be made, in fact, into a Bertrand prism—simply by proper cleavage, without any artificially-worked planes at all.

Hexagonal prisms of the mineral are of frequent occurrence; good, clear, regular-shaped specimens, 1 cm. (or more) in diameter, coming especially from Cumberland. The sides of these prisms are, of course, parallel to the optic axis; and hence a pair of opposite sides, if smooth and well developed, serve for two of the plane surfaces required for the Bertrand prism (see NATURE, May 15, p. 52) without any alteration. Moreover the crystal has a very strongly marked cleavage along the planes of the fundamental rhombohedron; and since these planes make angles of almost exactly 45° with the optic axis, a pair of them will supply the two remaining surfaces of the prism.

If, then, we select a good hexagonal prism of calcite, as shown below—



and carefully cleave it in two places, AB and CD, and allow a beam of ordinary light (preferably from an opal lamp shade) to enter the side of the prism near A, it will be affected in its passage through the crystal in the manner explained in my former letter (*ante*, p. 53), and the usual pair of ring-systems will be visible to an eye receiving the light emergent near D.

If there are any slight imperfections in the natural plane surfaces, we can easily improve upon Nature by cementing thin plates of glass upon them with Canada balsam.

Queen's College, Oxford. H. G. MADAN.

Testing for Colour-blindness.

MAY I ask, in connection with the lecture of Mr. Brudenell Carter, why those interested in the testing of colour-vision do not avail themselves of a scientific instrument like Lord Rayleigh's colour-box, wherein a given yellow has to be matched by proportions of red and green adjusted by turning a handle over a dial graduated on the back; instead of contenting themselves with crude methods, such as selection of coloured wools, which cannot give results definite enough to be of much interest, even if they were quite efficient in detecting the grossly colour-blind?

OLIVER J. LODGE.

IN Mr. Brudenell Carter's interesting paper read at the Royal Institution on Friday, May 9, a physiological explanation is suggested of an easily-verified fact of colour-perception.

An eye with the pupil dilated is proportionally more perceptive of red rays than one with the pupil contracted. If we stand at right angles to a window, or other light, shading the further eye with the hand, and look at a piece of white paper with the two eyes alternately, we shall find that, to the eye in the light, the tint of the paper seems distinctly colder than to the shaded eye.

Dr. Waelchli's observations of the retinal red zone in birds, surrounding the central green region, makes the cause of this phenomenon comparatively clear; while the phenomenon itself tends to prove that the distribution of colour-zones in the human eye resembles that of birds. E. H.

May 16.

I DO not know whether the following will be considered too trivial to be admitted as an illustration of Dr. Brudenell Carter's lecture.

About 30 years ago, being then an assistant master at a school, I one day asked an older colleague (since dead), "Who's that boy in the red cap?" Several were standing in a line, most of them with black caps. "Red cap?" said my friend; "I don't see any red cap" (it was scarlet flannel); "I can see the red head"—meaning another boy with so-called "red" hair.

The same gentleman could see no difference in colour between the flower and the leaf of the *Pirus japonica;* but it will be observed that he distinguished "red" hair without difficulty.

Otham Parsonage, Maidstone. F. M. MILLARD.

Red Spot on Jupiter.

ON May 22 last, at 15h., I observed Jupiter through a 10-inch reflector, power 252, and saw the red spot between the east limb and centre of the planet. It was rather faint, and not nearly so conspicuous as some of the belts in its vicinity. According to careful estimation, the spot reached the central meridian of Jupiter at 15h. 35m. This is 15·5 minutes before the time given in Mr. Marth's valuable "Ephemeris for Physical Observations of Jupiter," published in the *Monthly Notices* for March 1890, p. 344. The difference proves that the motion of the spot continues to accelerate in a slight degree relatively to the mean rate of rotation of 9h. 55m. 40·63s., adopted by Mr. Marth in his recent ephemerides. Observers, therefore, who wish to see the spot at mid-passage across the disk of Jupiter must turn their telescopes upon the planet at least a quarter of an hour before the predicted times based on the daily rate 870°·27.

During my observation on May 22 I saw a very dark, if not black, spot of circular form threading its way across the disk, and projected upon the northern half of the great north equatorial belt. I ascertained by reference afterwards to the *Nautical Almanac* that this object was the fourth satellite in transit.

Bristol, May 25. W. F. DENNING.

Coral Reefs, Fossil and Recent.

I PUBLISHED a review of the third edition of Darwin's "Coral Reefs," with appendix by Prof. Bonney, both in the *Biologisches Centralblatt* and in the *Naturwissenschaftliche Rundschau* of last year. This will, I think, considerably modify the meaning of Prof. Bonney's statements, published in NATURE of the 15th inst. (p. 53), according to which I was ignorant of this work of his when I wrote my letter on "Coral Reefs, Fossil and Recent." R. VON LENDENFELD.

Swallows at Sea.

THE following notes from my journal as to meeting swallows at sea during the autumn migration may be of use to anyone interested in that subject.

On board ss. *Port Victor* from Plymouth to Sydney, 1889.—"October 31, lat. 16° N., long. 19° W. A quantity of swallows flying about the ship evidently tired and very tame, perching freely within a few feet of anyone. Look thin. A solitary swallow or two were seen yesterday and day before in lats. 20° and 24° N. respectively. 9 p.m., passed Cape Verde at a distance of forty miles.

"*November* 1.—The swallows roosted last night on board, and left during the forenoon, with the exception of one or two who remained on board all day. Saw a curlew and a wagtail at noon, lat. 12° N., long. 18° W.

"*November* 2.—One swallow still on board, roosted last night on the poop. Calm. Saw a wagtail.

"*November* 3.—Five swallows and two martins about the ship, apparently in very fair condition, so tame that they would perch on one's hand; had three or four sitting on my hand at once sometimes. Noon, lat. 5° N., long. 14° W., about 150 miles off land.

"*November* 4.—Swallows left, could not see in what direction they went. Picked up south-east trade, lat. 2° N."

HERBERT E. PUREY-CUST.

H.M.S. *Egeria*, Auckland, April 6.

The Corolla in Flower-Fertilization.

I HAVE noticed a curious fact in reference to the blue gentian of the garden here that will interest you. This flower (like the daisy) closes at night and opens in the morning, and is exquisitely sensitive to the time of sun rising and setting (it is a lasting, and with its bronzed throat an exquisite flower). The fact observed is this, that, when visited by the large handsome bee that fertilizes it, the beautiful widespread pentamerous flower closes gently on the bee, if the insect effectually enters and fertilizes it, on its passage to the honey of the five cups at the base of the corolla; and after the insect's exit, does not again unfold, if the fertilization is complete, but remains a folded flower—a protection (shorn of its beauty) for the precious seed-vessel and its maturing contents within. JOHN HARKER.

Hazel Grove, near Carnforth, May 13.

Popocatapetl.

IN vol. xli. of NATURE, (p. 592) you state: "Despatches from Mexico state that observations show that the height of the active volcano Popocatapetl has decreased by 3000 feet since the last measurement." This despatch, which was forwarded from Prof. Heilprin's party now in Mexico, would seem to indicate that there has recently been an actual *loss* of height in Popocatapetl; whereas Prof. Heilprin's object was to indicate that the observations hitherto accepted are inaccurate.

EDMUND J. DE VALOIS.

295 Adelphi Street, Brooklyn, N.Y.,
May 16.

CHEMICAL CHANGES IN ROCKS UNDER MECHANICAL STRESSES[1]

AFTER pointing out that his object was to inquire how far the experimental researches of chemists and physicists are capable of affording a satisfactory explanation of the phenomena observed when the rocks of the earth's crust are studied microscopically in thin sections, the lecturer proceeded to give a *résumé* of the experimental investigations of Daubrée, Bunsen, Sorby, Thorpe, Spring, Guthrie, Fouqué, Michel-Lévy, and other chemists, who have devoted their attention to the action of pressure in influencing chemical affinity. The evidence that the deeper-seated rock-masses of the globe, and those constituting mountain-chains, have been subject to enormous pressures was then indicated; and the difference between the statical pressures arising from a great weight of superincumbent rocks, and the dynamical pressures resulting in actual movements within the earth's crust, was insisted upon. The chemical and physical principles which have been established by direct experiment, and which, at the same time, appear to be illustrated by the observations that have been made during recent years upon the minute structure of rocks, and of the minerals composing them, were stated in the following series of propositions:—

I. *In all those cases in which crystallization is accompanied by contraction, the tendency of pressure is to promote the change from an amorphous to a crystalline condition.*

Spring has shown that under a pressure of 6000 atmospheres plastic or amorphous sulphur, having a density of 1·95, passes into rhombic, crystallized sulphur, having a density of 2·05.

The mixtures of silicates which constitute the igneous rocks of the earth's crust all undergo *contraction* in passing from the amorphous (vitreous) to the crystalline condition. This is easily proved by comparing the specific gravities of more or less crystalline rock-masses with that of the glasses formed by their artificial fusion. The experiments of Delesse, Deville, Cossa, and others have shown that mixtures of the silicates of alumina and the alkalies with over 70 per cent. of silica, must undergo a contraction to the extent of $\frac{1}{17}$ of their bulk in passing from a glassy to a highly crystalline state (granite). Mixtures of the silicates of alumina, magnesia, iron, lime, and the alkalies with less than 50 per cent. of silica, in passing from a vitreous state to a perfectly crystalline one (gabbro), must undergo a reduction in bulk equal to $\frac{1}{4}$.

It may fairly be anticipated, therefore, that great pressure would tend to promote the crystallization of the mixtures of silicates composing most of the rocks of our globe, or to prevent their assuming the glassy state; and a great body of geological facts tends to support this conclusion. It must not, of course, be lost sight of that slow consolidation is also favourable to the process of crystallization, and rocks being extremely bad conductors, the process of cooling in great rock-masses is excessively slow. It is often difficult therefore to discriminate between the effects that must be referred to slowness of cooling, and those which may be safely considered to result from pressure.

As long ago as 1846, Charles Darwin showed that the andesitic lavas of the Cordillera of South America are associated with perfectly crystalline rock, true granites, made up of precisely the same minerals. The identity of the minerals in the plutonic rocks and the lavas respectively was demonstrated by the careful studies of Darwin himself, and of Prof. W. H. Miller, of Cambridge, long before the method of studying rocks in thin sections had been invented. Quite recently Prof. A. Stelzner, employing the modern methods of research, has been able to completely confirm the interesting results arrived at by Darwin and Miller, and to show that a perfect gradation can be traced between the highly crystalline "Andengranites," and the more or less glassy lavas (andesites) which are so closely associated with them.

In 1874 I was able to show that in the Western Isles of Scotland there occurred masses of perfectly crystalline (granitic) rock, identified by Zirkel as true gabbros and granites, which can be traced passing by the most insensible gradations into natural glasses ("tachylytes" and "obsidians") (Quart. Journ. Geol. Soc., xxx., 1874, 233–48), and the truth of these conclusions has been fully established by the more recent researches of Dr. A. Geikie (Trans. Roy. Soc. Edinb., 1888, 122–24, 145–50). In 1876 I further showed that the diorites and quartz-diorites of Hungary and Transylvania pass insensibly into the ordinary lavas of the district, which have the same ultimate chemical composition, and the same mineralogical constitution (Quart. Journ. Geol. Soc., xxxii., 1876, 292). In 1885, Messrs. Arnold, Hague, and J. P. Iddings, of the United States Geological Survey, established precisely similar conclusions by the study of rocks in the Nevada district (Bull. U.S. Geol. Surv., No. 17, 1885); and Signor B. Lotti, of the Italian Geological Survey, in the following year proved the same to be true in the case of the rocks of Elba.

In all these cases it is seen that the masses which have been most deeply seated, and thus subjected to the greatest statical pressures, are those which have undergone the most perfect crystallization. It must of course be remembered that in these cases the other cause tending to the development of crystalline structure comes into play—namely, slowness of cooling. The ordinary materials of igneous rocks are such bad conductors of heat, that enormous periods of time must elapse before the deeply seated portions of igneous rock-masses can become solidified.

The potent influence of this extreme slowness of cooling in bringing about the crystalline structure in molten masses of silicates has been well illustrated by the splendid researches on rock-synthesis by MM. Fouqué and A. Michel-Lévy. They have shown that the secret of making a particular mineral crystallize out of such a mass consists in finding out the temperature of fusion of the mineral, and in maintaining the molten mass for a long period just below this temperature. In the excessively slow cooling of deeply seated rock-masses, the materials must be kept successively and for long periods at temperatures a little below the fusion-points of each of their mineral constituents.

But while the influence of slow cooling in producing the crystalline structure in rocks is unquestionably very great, the effect of pressure in promoting crystallization can scarcely be doubted. We have no proof, indeed, that the holocrystalline or perfectly granitic structure of rocks can ever be produced except under these conditions of extreme pressure.

II. *Crystallized minerals, developed in a magma under pressure, may lose their stability and be dissolved by the same magma when the pressure is removed.*

The very remarkable researches of Fouqué and Michel-

[1] "The Evidence afforded by Petrographical Research of the Occurrence of Chemical Change under Great Pressure." A Lecture delivered before the Chemical Society, March 20, 1890, by Prof. J. W. Judd, F.R.S.

Lévy upon the synthesis of rocks is not less instructive, whether we consider the successes or the failures of their experiments. While able to reproduce by fusion and slow cooling—either from the powdered rocks themselves, or from duly admixed proportions of silica, alumina, iron oxide, and the alkaline earths and alkalies—various kinds of basalts and other basic rocks, all attempts to form certain other rocks, especially those containing quartz, hornblende, and muscovite, failed. The conclusion at which the experimenters arrive—and the correctness of this conclusion it is scarcely possible to doubt—is that, for the formation of such minerals and of the rocks containing them, water and other volatile substances, held within the solid mass by intense pressure, is absolutely indispensable.

Now in the porphyritic constituents (*Einsprenlinge* or phenocrysts) of many lavas, we find examples of minerals which have been formed at great depths in the earth's crust and then brought up to the surface and exposed to totally different conditions, especially as regards pressure. Very clearly do these phenocrysts tell the tale of their origin, and of the influence exerted upon them by their subsequent environments.

Crystals of quartz and felspar, which have grown to large proportions in the deeper portions of the earth's crust, are found when brought up in lavas to the earth's surface, and thus relieved from the action of pressure, to be attacked by the magma in which they were originally formed. The proof of this is seen in the corroded condition of the crystals, the glassy matter surrounding them having attacked their angles, their edges, and in a less degree their whole surface, penetrating irregularly into their interior, and reducing them sometimes to mere skeletons.

Crystals of hornblende and mica betray in an even more striking manner the effects of a change of environment. When brought up from great depths in masses of molten lava, crystals of these minerals are constantly found to be surrounded by "resorption halos." The outside of the hornblende or mica crystals, where in contact with the molten glass, is found to be attacked by it, and crystals of pyroxene and magnetite have resulted from the reaction. The action may in some cases continue till the whole of the hornblende has been converted into a pseudomorph.

In some instances there may be reason to believe that the phenocrysts have become enveloped in a magma of different chemical composition to that in which they were originally formed. But in many cases there is no room for doubt that the minerals which were formed and maintained their stability under certain conditions of pressure, lost that stability upon the diminution of pressure.

That, conversely, the increase of pressure leads to the production of a condition of instability in minerals formed at or near the earth's surface there cannot be any doubt. The study of the formation of crystalline schists from various aqueous and igneous rocks supplies us with numerous and very interesting illustrations of changes of this kind: hornblendes, chlorites, micas, and talc are produced under conditions of pressure in which pyroxenes, epidotes, felspars, and olivines lose their stability.

III. *In all those cases where solution is attended by contraction, the solvent action of water and other liquids is increased by pressure.*

That this is the case at elevated temperatures is proved by the researches of Daubrée to which we have already referred. Pure water was made to attack various silicates quite insoluble at ordinary temperatures and pressures. Even if we admit with Bunsen that there are temperatures at which this influence of pressure is no longer operative, or at which the effects are wholly inappreciable, the admission would not in any way affect the theoretical views of the geologist, seeing that the increase of temperature within the earth's crust is so rapid, that even at moderate depths the temperature at which solvent action is increased by pressure must certainly exist.

The *effects* of this solvent action under pressure are everywhere manifest when we come to the study of the rocks building up our earth's crust. At more or less considerable depths, water containing carbon dioxide has attacked the silicates composing the rock-forming minerals; so that it is impossible to find rocks which have been deep-seated, at any period of their history, in which the minerals are in a perfectly unchanged condition.

Great masses composed originally of calcic carbonate, are found to have been changed into dolomite (the magneso-calcic carbonate), or into chalybite (the ferrous carbonate); while in other cases the whole mass of a bed of calcic carbonate has been dissolved away, and silica substituted as a "pseudomorph."

We must proceed to study the details of such processes especially as they are affected by pressure and by the crystalline structure of the minerals affected.

IV. *Under great statical pressures, the whole substance of solid bodies may be permeated by fluids, and chemical reactions between them are thus greatly facilitated.*

It is not necessary to point out that the molecules of the densest solids cannot be in actual contact; this is proved by the circumstance that such solids undergo contraction by lowering of temperature, and that gases may be occluded in them. Physicists and mathematicians, as recently pointed out to this Society by Prof. Rücker, have even been able to arrive at positive conclusions concerning, not only the actual order of magnitude of molecules, but the *distances* that separate them from one another in solids.

The effect of pressure in causing the molecules of one body to pass between those of another, has been expressed by Van der Waals in the dictum, "All bodies can mix with one another, when the pressure exceeds a certain value." A similar conclusion was expressed by the late Dr. Guthrie, as the result of his experiments on potassic nitrate, when he asserted that "fused nitre and fused ice are miscible in all proportions."

Now, nothing is more certain, from petrographical researches, than that the whole substance of the minerals in the deep-seated rock-masses of the globe may be permeated by fluids. This is shown by the condition of the minerals forming these deep-seated masses.

The felspars, in their normal condition, are colourless and transparent minerals with a vitreous lustre, and this is their character when they are found in lavas and in blocks ejected from volcanoes. In granites and other deep-seated rocks, however, these same felspars exhibit grey, green, pink, or red tints, with more or less opacity, and a remarkably pearly lustre. The cause of this change of aspect is found in the fact that the unstable alkaline silicates which enter into their composition have been attacked by the fluids that have penetrated through the whole substance of the crystal, leading to the formation of the hydrated silicates of alumina, and, in some cases, the peroxidation of any traces of iron compounds that may have been present in them.

Similar changes can be shown to have affected most, if not all, the minerals which, at any period of their history have formed portions of deep-seated rock-masses.

V. *By the intimate intermixture, under great statical pressures, of solids and fluids, the properties of the former undergo great modifications.*

Bunsen, in common with all chemists who have studied the great problem of geology, has insisted that fused silicates, in spite of the high temperatures at which they assume the fluid state, obey the same laws as those governing ordinary solutions. Guthrie has shown that the principles which determine the formation of "cryo-

hydrates" and of "eutectic compounds" are equally operative in the case of the separation of minerals from a mixture of fused silicates; and the same idea has been elaborated by Lagorio. Guthrie has further shown that, as water is added to a salt, the fusion-point of the mixture is progressively lowered, and from this fact he concludes that "the phenomenon of fusion is nothing more than an extreme case of liquefaction by solution."

That silicates, when they are mixed with water, fuse at a lower temperature, was long ago recognized by geologists—long, indeed, before any physical explanation had been offered of the fact. Poulett-Scrope, Scheerer, Elie de Beaumont, Daubrée, and many others who might be mentioned, have insisted on the important part played by water in promoting the fusion of lavas and other igneous masses.

In the case of the volcanic glass known as *marekanite*, I have shown that at a comparatively low temperature the mass will, when heated, swell up and intumesce, the escaping steam causing the molten glass to froth up and assume the character of a true pumice (*Geol. Mag.*, Dec. 3, iii. 243). The brown glass ejected from Krakatão, during the great eruption of 1883, if heated, increases to many times its original bulk, and passes into a substance which, macroscopically and microscopically, is indistinguishable from the pumice thrown out in such vast quantities during that great eruption (*Geol. Mag.*, Dec. 3, v. 6).

Many volcanic glasses contain an appreciable quantity of water, amounting in some cases, indeed, to as much as 10 per cent. of their mass. The glasses which contain water fuse at a lower temperature than those which are anhydrous. There is reason to believe that most lavas are not masses in a state of simple fusion, but consist of crystals floating in a mass of mixed silicates and water, the magma being at a temperature above the fusion-point of the mixture but below that of the crystals.

VI. *Mechanical stresses, which tend to overcome the attraction between the particles of a solid, promote chemical action at those parts of its mass which are in a condition of intense strain.*

That a direct relation exists between mechanical and chemical forces is shown by the fact that capillary action is capable of overcoming weak chemical affinities. Violent mechanical shocks will sometimes completely overmaster chemical affinity, as was shown by Berthelot in the case of acetylene, cyanogen, &c., and more recently by Prof. Thorpe in the case of carbon disulphide.

Carnelley and Schlerchmann endeavoured to show that the solution of a copper wire by acid was promoted when the wire was put into a condition of strain. These experiments, it is true, yielded negative results, a circumstance which is, perhaps, hardly to be wondered at, when we remember how feeble were the mechanical forces employed.

In the case of the curiously impressed limestone pebbles of the Swiss Nagelflue, however, Sorby has shown that there are grounds for believing that solution is promoted in masses which are subjected to intense mechanical stresses, and he has confirmed this conclusion by an ingenious experiment with rock-salt (Yorksh. Proc. Geol. Soc., iv. 458-61).

Similarly impressed and faulted pebbles from the Old Red Sandstone of Stonehaven, in Scotland, have afforded what I think is indisputable evidence of the action of strain in promoting solution. The sand-grains, of which these pebbles are composed, are seen under the microscope to be traversed by bands of liquid enclosures that are clearly of *secondary* origin. Now, these bands of enclosures are parallel to the actual faults that have been produced in the pebbles, and the careful study of all the facts renders inevitable the conclusion that when the whole mass, under great statical pressures, was permeated by fluids, solvent action was determined in parts of the mass subjected to violent strain (*Mineralogical Magazine*, vii. 83).

Similar bands of secondary liquid inclusions, which have clearly been produced in the same way, abound in the crystals of many rock-masses that have been subjected to strain and movement.

VII. *Pressure may supply the conditions required for the renewal of the growth of crystals when their development has been arrested for an indefinite period, and even after they have suffered mechanical injuries.*

In 1856, Louis Pasteur published the results of his interesting investigations upon the property exhibited by bimalate of ammonia and other salts, the crystals of which are able to repair injuries produced by fracture; and this experiment has been repeated and confirmed by Scharff and other observers.

This principle of the growth and repair of injured crystals is one of great importance and wide application in geological investigation. Sorby has shown that rounded and water-worn sand-grains that have originally constituted a portion of granite or other igneous rock may, in the presence of solutions of silica and under pressure, renew their growth, and, in the end, acquire the faces and angles characteristic of quartz-crystals The observations of Becke, R. Irving, Van Hise, Bonney, and other microscopists have shown that, not only fragments of quartz, but portions of the crystals of felspar, augite, hornblende, biotite, and other minerals, may undergo enlargement in a similar way. It has further been shown that this repairing and growth of crystals is continually taking place in rocks under pressure; that the composition of the outer parts of a crystal may vary as growth goes on; and that the action can take place in solid rock-masses (Quart. Journ. Geol. Soc., xlv. 175–86).

I have found it possible to illustrate experimentally some of the phenomena exhibited by zoned crystals in rocks. An octahedral crystal of chrome-alum of a dark-purple colour was mutilated by having two opposite solid angles broken off from it and then placed in a solution of common ammonia-alum (see Fig. 1). By more rapid

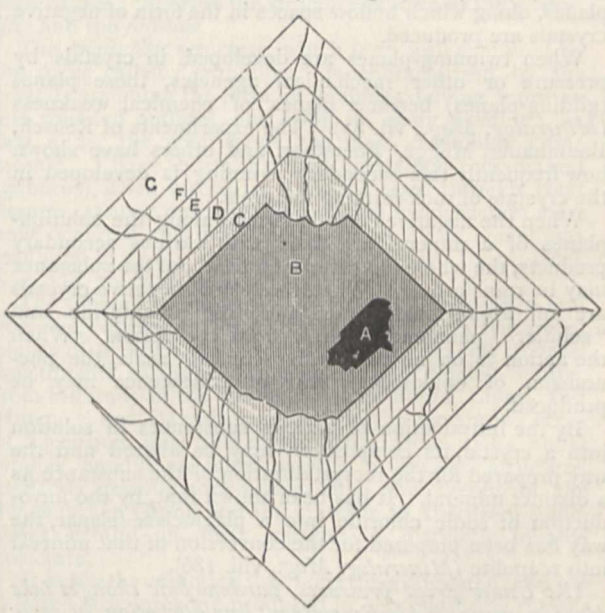


FIG. 1

growth in the injured portions, the crystal tended to repair itself, but the regularity of this process was interfered with by subjecting the crystal and solution to a somewhat wide range of temperature. As the coefficient of expansion of chrome-alum appears to be different from that of ammonia-alum, the shell of the latter material

was from time to time cracked by the unequal expansion. The solvent, finding its way into the interior, partially dissolved away the original crystal of chrome-alum. The final result of these changes was that while the form of the alum octahedron was almost completely reproduced, only a small portion (A) of the original chrome-alum crystal remained. Much of the chrome-alum was dissolved out and replaced by a mixture of the two alums (B), while the other layers of the crystal (C, D, E, F, G) were formed by still paler-coloured zones, also consisting of mixtures of a like kind. Zoned crystals exhibiting similar abnormal appearances to this alum crystal are by no means rare in some igneous rocks.

VIII. *When solution under pressure is going on in a crystalline body, the action is controlled and modified by its molecular structure. This molecular structure may have been produced either in the process of crystallization, or as the result of mechanical or other forces acting upon the crystal subsequently to its formation.*

Daniell's earliest contributions to science, in the year 1816, dealt with the remarkable and unequal action of solvents upon crystals. The curious and complicated patterns produced on the faces and the cleavage or cut surfaces of crystals (etching-figures) have subsequently been studied by Leydolt, Klocke, Baumhauer, Becke, and other investigators. The results obtained have been shown to vary with the nature and strength of the solvent, the temperature, the pressure, and the time during which the action is allowed to take place.

In 1884–85, Von Ebner, as the result of an exhaustive study of the etching-figures of calcite and aragonite, showed that crystals possess *planes of chemical weakness*, to which he gave the name of "solution-planes," these being analogous to the well-known planes of least cohesion or cleavage-planes. Quite independently, I, about the same time, arrived at the same conclusion by studying the crystals in deep-seated rocks (Quart. Journ. Geol. Soc., xli. 383, &c.). In these deep-seated rocks the crystals (their whole substance being permeated by the solvent) yield to chemical action along their solution-planes, along which hollow spaces in the form of negative crystals are produced.

When twinning-planes are developed in crystals by pressure or other mechanical agencies, these planes (gliding-planes) become planes of chemical weakness (*Mineralog. Mag.*, vii. 87). The experiments of Reusch, Baumhauer, Mügge, Foerstner, and others have shown how frequently this secondary twinning is developed in the crystals of rock-forming minerals.

When the negative crystals formed along the solution-planes of a mineral are filled with various secondary products, the whole character and aspect of the substance may be transformed. When the infilled negative crystals are of appreciable dimensions, the avanturine and "schiller" phenomena result from the action. When the action is on an ultra-microscopical scale, the phenomena of opalescence and of iridescence may be produced.

By the introduction of various substances in solution into a crystal, its composition may be altered and the way prepared for the recrystallization of the substance as a distinct mineral. It has been shown that, by the introduction of sodic chloride into a plagioclase-felspar, the way has been prepared for the conversion of that mineral into scapolite (*Mineralog. Mag.*, viii. 186).

IX. *Under great pressures, paramorphic changes take place in crystalline bodies without any alteration in their chemical composition.*

It is a well-known fact that, under the slight pressure which can be exerted by the hand, the orthorhombic, yellow variety of mercuric iodide passes into the tetragonal, red variety. Spring has shown that, under a pressure of 5000 atmospheres, monoclinic sulphur passes, at ordinary temperatures, into the orthorhombic form. Van 't Hoff and Reicher have shown that the temperature at which this latter change takes place is progressively diminished as the pressure is increased.

That slight forces acting through a considerable period of time are competent to produce such paramorphic changes has long been known. Thus the mercuric iodide and sulphur undergo their paramorphic changes slowly when subjected only to the ordinary vicissitudes of atmospheric temperature.

Many interesting examples of similar heteromorphous forms of the same compound are familiar to geologists, such as calcite and aragonite among the carbonates, and pyroxenes and amphiboles among the silicates. Heteromorphism, indeed, appears to be the rule rather than the exception in the mineral kingdom.

The slow paramorphic changes between heteromorphous forms of the same compound was long ago studied by Gustav Rose; and in more recent years the dependence of these changes on great pressures, or on small forces acting through long periods of time, has engaged the attention of J. A. Phillips, Allport, Hawes, R. D. Irving, J. Lehmann, G. H. Williams, Teall, and other observers.

In considering these paramorphic changes, it must be remembered that the transition under pressure is not always, as in the case of sulphur, from a less dense to a more dense form. On the contrary, as in the change of both aragonite to calcite and of augite to hornblende, we find the denser but less stable form passing into the less dense but more stable one. Stability, however, is only a relative term: while one form of a compound may be most stable at one temperature or under a certain pressure, other conditions may exist under which it becomes an unstable form.

X. *Both solution and the formation of new crystalline compounds may result from pressure, and these two operations may take place together; in this way more or less complete interchange of ingredients may take place between the crystalline bodies, and pseudomorphs be formed.*

That most of the pseudomorphic changes, so common in the mineral kingdom, take place at considerable depths from the surface there seems no room to doubt; and in all these cases it may be inferred that pressure is one of the determining conditions of the action.

The effects of these pseudomorphic changes in transforming vast rock-masses into others of totally different composition—such as limestone into dolomite, chalybite, or silica—has long been familiar to geologists; and modern microscopical methods have enabled us to trace the progress of these changes from their earliest beginnings to their complete consummation.

Without entering further into this very wide question, I may mention that Mr. G. F. Becker has lately published the full details of his studies of the Coast-Ranges of California, and that these tend to prove that, in comparatively recent geological times, vast masses of rock in that district have had their substance replaced in some cases by silica, and in others by serpentine; the changes sometimes taking place over considerable areas. These conclusions, arrived at by the officers of the U.S. Geological Survey, if fully established—and there appears to be no room for doubt as to their general accuracy—are not less interesting and suggestive than they are novel and startling.

XI. *When, as the result of dynamical pressures, the crystalline constituents of rocks are brought into close contact, chemical affinity comes into play between them, and new mineral species result from the reactions that take place. This operation is facilitated, when, as a consequence of internal strains, differential movements are set up within the rock-mass, and rubbing or sliding contacts between its particles are brought about.*

Chemists are acquainted with many examples of che-

mical action following from the simple bringing into close contact of molecules. In the union of gases, when they are condensed by platinum-black, and even in the light rubbing of a safety-match on the match-box, we have illustrations of such phenomena.

Spring has shown that, when powdered metals are mixed together and subjected to great pressures, union takes place between them, and alloys are formed. When dry anhydrous salts are similarly treated, double decomposition takes place, and new compounds are formed.

Prof. Thorpe has shown that dry anhydrous salts may be made to react with one another by being simply rubbed together in a mortar; and both Mr. Hallock and Prof. Spring are agreed as to the intensification of action which occurs when rubbing or sliding movements—attended with necessary multiplication of points of contact in compressed bodies—takes place.

Lastly, it may be pointed out that Spring has recently shown *time* to be a very important factor in such changes, by allowing slow diffusion to take place at the surfaces of contact.

That the rocks known as "crystalline schists and gneisses" have had their peculiar characters produced by "internal differential movements," resulting from "enormous irregular pressures," was clearly recognized by Poulett-Scrope, Darwin, Naumann, and Sharpe long before the researches of physicists and chemists had supplied us with the explanation of the phenomena. Modern petrography has confirmed and illustrated these conclusions, enabling us to study the actual stages of the processes of change by which, through the reaction of the constituent minerals of a rock under pressure, the whole mass resolves itself into a completely different mineral-aggregate. The labours of Lossen in the Hartz, of J. Lehmann in Saxony, and of H. Reusch in Norway, have been of especial value in establishing these important conclusions.

As an illustration of this kind of action, we cannot, perhaps, do better than take the case of a rock (gabbro) consisting of three somewhat unstable constituents (see Fig. 2), labradorite (A), pyroxene (B), and olivine (C). In

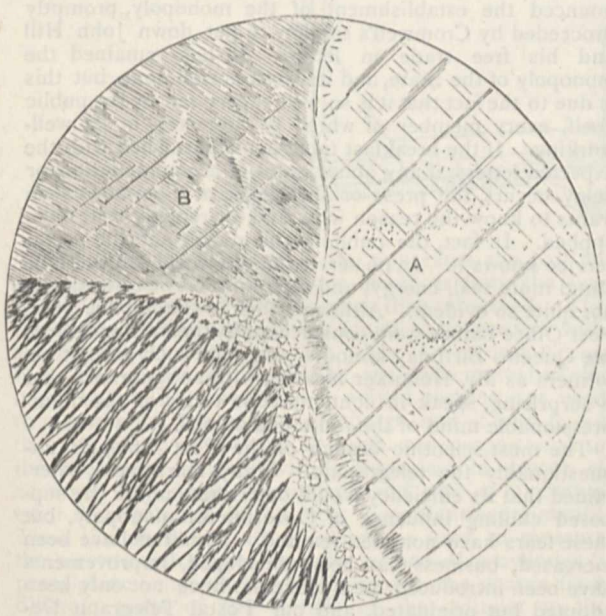


FIG. 2.

the rock from which the figure has been taken, there are clear evidences of its having been subjected to deforming stresses. Where the olivine, the least stable of the three minerals, is in contact with the labradorite, the silicates of which they are composed have reacted upon one another. The result is seen in the formation of a zone between them, consisting of entirely new minerals—a pyroxene (D), and a hornblende (E). Similar changes, but not so strongly marked, are seen to be in progress between the olivine and the pyroxene, and between the pyroxene and the labradorite.

By carefully selecting and studying a series of specimens from the same rock-mass, every step in the metamorphosis of a rock may be followed, from incipient changes like those in the case above illustrated, to the final disappearance of every vestige of the original mineral constituents of the rock, and the substitution of new mineral species.

XII. *When internal strains and differential movements affect a mass, which is at the same time undergoing recrystallization, the forms and relations of the crystalline particles that build up the new rock may be greatly modified by the action of the mechanical forces.*

That perfect rest is a condition upon which well-developed crystallization depends, is a fact too well known to need dwelling upon here. That very small mechanical causes, such as the presence of foreign bodies, or the existence of rough surfaces, may determine the size and position of crystals in a solidifying mass, is also a fact familiar to every chemist. By stirring or similar movements carried on within a crystallizing mass, granulation, or the formation of a number of small imperfect crystals, rather than of large and well-developed ones, is brought about; as in the well-known Pattison's process for desilverizing lead.

The evidence of perfectly similar actions having taken place in crystallizing rock-masses is everywhere conspicuous; and the results are the same, whether the crystallization occurred in a mass passing from a fluid to a solid state, or in a mass which remained solid during the whole process of recrystallization.

There are two structures which are especially exhibited by rocks that have been subjected to dynamo-metamorphism which seem clearly to have been produced by such causes; these are the structures known as the *granulitic* and the *foliated*.

The *granulitic* structure, which is so well exhibited by the rocks called "granulites," is characterized by the crystals assuming the form of granules, having more or less rounded outlines, and lying in every position; so that, under the polariscope, the mass resembles a fine mosaic. I have shown that well crystalline rock-masses (gabbros), when forced in a molten state through great fissures, assume on their edges, where much friction must have occurred, this granulitic habit, which is sometimes exhibited in a very striking manner (Quart. Journ. Geol. Soc., xlii. 76, &c.).

The foliated structure, so characteristic of schists and gneisses, consists in the separation along nearly parallel planes of leaf-like patches (folia) of the several mineral constituents of the crystallizing mass. Poulett-Scrope, from his study of the viscous lavas of Ponza, Lipari, and Hungary, and Darwin, from his study of the similar lavas of Ascension, were able to show that these rocks, under similar conditions, often assume a *foliated* structure. Perfectly granitic rock-masses, like the syenite of the Plauenschen Grund and the granitite of Aberdeen, sometimes exhibit on their margins a distinctly foliated structure.

It is worthy of notice that both the granulated and the foliated structures are produced in recrystallizing masses that are subjected to internal strains and differential movements. They are equally produced when the mass has been a liquid which has slowly passed into the solid state by the process of crystallization; and when by the processes we have already considered the mass, *retaining its solidity*, has undergone internal molecular rearrangement and recrystallization.

A rock-mass behaves as a viscous body, under slight pressures, when heat and the presence of water have overcome the cohesion of its particles. But the researches of Tresca and Daubrée have shown that, when subjected to sufficiently powerful stresses, the most perfectly solid bodies we know of behave like viscous bodies, and can be made to *flow*.

In the foregoing remarks, my main object has been to show how far the physical and chemical principles, which have been established by actual experiment, are capable of explaining the phenomena observed by the geologist in studying the earth's crust. I have especially avoided invoking any causes which must be regarded as hypothetical.

Some of the actions relied upon as explaining the origin of the great features of the rock-masses which compose the earth's crust may seem at first sight small and even insignificant. But the great lesson taught by modern geological science is that such small forces, operating upon enormous masses of matter during vast periods of time, are capable of effecting the most stupendous results.

In speaking of *statical* pressure, I have not treated it as an agent of change, like heat or electricity, but simply as a condition under which these agents operate—one which may profoundly modify or control their action. Such pressure, too, may produce great effects by causing a closer contact and consequent chemical action between the molecules of a fluid made to penetrate a solid, or between the molecules of two solids forced into more perfect contact. Statical pressure may, further, prevent the escape of volatile materials even under extreme temperatures, and these substances, as in the case of the "mineralizers" of the French chemists, may exercise important influences on the solids or liquids within which they are retained.

Dynamical pressure, especially when it results in differential movements in a mass, can certainly do all that is effected by statical pressure, and perhaps something more. That such motion is converted into heat there can be no doubt; and some geologists, like the late R. Mallet and Prof. Prestwich, have argued that the heat so produced must have played an important part in the work of metamorphism. But considering the slowness with which the earth-movements have probably taken place, and the opportunities for the dissipation of this thermal energy, it may be regarded as at least doubtful if at a particular point in the rock-mass the temperature could ever have been raised to such an extent, that any very important part of the work of metamorphism ought to be ascribed to it. In the same way, we may, perhaps, regard the suggestion of Mr. Sorby that, during great earth-movements, mechanical energy is directly converted into chemical energy, as one in favour of which no convincing evidence has as yet been adduced.

It is at least conceivable that the realm of excessively *high* pressures is one in which phenomena may be displayed which are as anomalous as those exhibited under extremely *low* pressures—the high *vacua* of Mr. Crookes. But until such effects have been demonstrated by actual experiment, it is unwise to invoke their aid in geological hypothesis. My great object, in the remarks I have ventured to offer you this evening, has been to show that, on well-established physical and chemical principles, the phenomena, which are exhibited by rock-masses that have been subjected to great pressures, are capable of satisfactory explanation.

THE UNIFORM PENNY POST.

OF all the jubilees that are now being celebrated, there is none which has had a more beneficial influence on the age than that celebrated last week at the Guildhall, with such success and good management. There are some who deplore the decay of letter-writing, and even a few who regard the penny post as an unmitigated evil, but no one can fail to perceive that the conduct of the great commercial business of this country would have been impossible without cheap postage.

We are not celebrating the penny post. This was proposed in 1659, by one John Hill, an attorney of York—curiously enough a namesake of Sir Rowland's—who showed its practicability and advocated free trade in letter-carrying. He proposed a rate of 1*d.* in England, 2*d.* in Scotland, and 4*d.* in Ireland, as well as 3*d.* per ounce for small parcels.

Nor are we celebrating the invention of adhesive stamps, but the introduction, in 1840, of that great measure which swept away a sliding scale of postage of single letters written on single sheets of paper which varied between 4*d.* and 1*s.*, and a system of franking that had grown, even in the reign of our present Queen, to a most shameful abuse. Envelopes or covers and enclosures involved double postage. If the letter weighed an ounce the rate was quadrupled. A single letter, London to Brighton, cost 8*d.*, to Edinburgh 1*s.* 1½*d.*, to Cork 1*s.* 5*d.*; or if it weighed 1¾ ounces, to Edinburgh 7*s.* 7½*d.*, to Cork 9*s.* 11*d.* The number of letters passing through the post in 1839 was 76,000,000. In 1889, it amounted to 1,600,000,000, and this excludes newspapers, post-cards, books, and parcels. The grand total for 1889 was 2,362,000,000.

It is not too much to say that the transport of this enormous mass of material would have been impossible but for the advent of steam. Railways and steam-boats have led to the possibility of the uniform post. Telegraphs have made its administration practical and simple. Without these practical applications of science its success would have been impossible. Pack-horses, mail-coaches, and sailing-vessels, would have failed to transport mails with the celerity, trustworthiness, and regularity, that are the essentials of a true postal service.

The Stuarts made the Post Office a monopoly of the Crown; and the Commons, who in Charles's day denounced the establishment of the monopoly, promptly proceeded by Cromwell's soldiers to put down John Hill and his free trade in letters. It has remained the monopoly of the State, and its work is well done, but this is due to the fact that it is so well supervised by the public itself, every member of which is interested in its well-working. If the breakfast table is not garnished with the expected letters, if any abuse, want of accommodation, or delay occurs, the press or the House of Commons soon wants to know the reason why, and the remedy is at once applied. In fact, the public is the master and the postal service knows it. In no service in the world can there be found more zeal, energy, and attention. The rewards are not quite so evident. Although this is the jubilee year, Post Office names were conspicuous by their absence from the Queen's Birthday honours, and even such ardent reformers as Mr. Henniker Heaton, with an ignorance that is surprising, speak in contemptuous terms of the unimpressionable mind of the red-taped official.

The most scientific branch of the Post Office is unquestionably the telegraphic. Many fears were entertained that its efficiency would deteriorate under the supposed chilling influence of Government monopoly, but these fears have not been realized. Facilities have been increased, business has been developed, improvements have been introduced, new processes have not only been adopted but originated, and our Postal Telegraph Department unquestionably holds the most prominent position in the world at the present moment. The number of messages, which in 1869, the year before the transfer, amounted to 6,000,000, now reaches over 60,000,000. Duplex, quadruplex, and sexuplex methods have been made practical. The automatic system of Wheatstone,

which its ardent inventor hoped would work well at 120 words, now works equally well at 600 words a minute.

The telephone, owing to mismanagement and the operation of our Patent Laws, has not received much development in England yet; but with the expiry of the patents at the end of this year it is hoped that every post-office will become an exchange, and the business of telephony will flourish as well in England as it has in Sweden and Norway and some of the smaller States in Europe. Competition and free trade will certainly tend to bring this marvellous and beautiful apparatus within the sphere of every domestic circle.

It is marvellous how science is rapidly becoming a household god. The electric light, bells, and telephones must prompt all to some knowledge of electricity. Ventilation, sanitation, pure water, warming apparatus, lead to a knowledge of other scientific principles. The laws of Nature are rapidly but surely becoming as familiar in our mouths as household words.

PENDULUM ELECTROMETER.

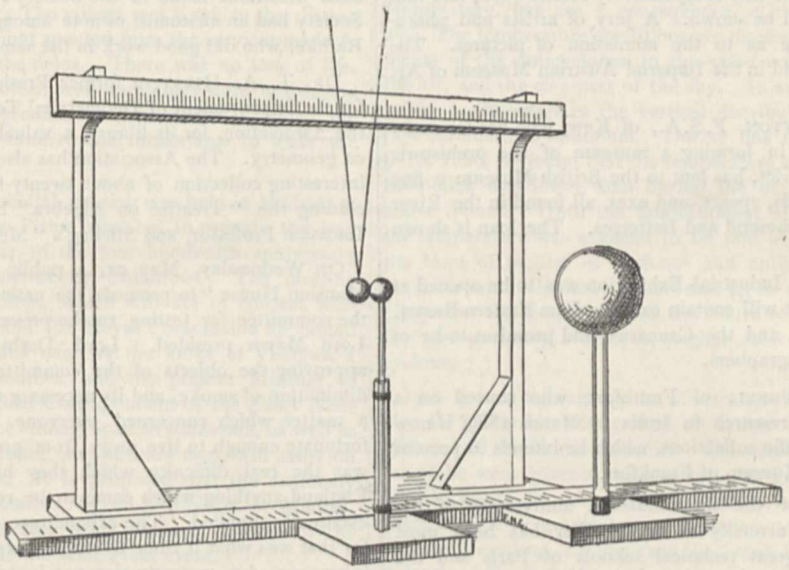
IN order to obtain an inexpensive apparatus by which the nature of electrostatic measurements could be clearly presented to students, and the measurements carried out before a class with ease and despatch in absolute units, Prof. Mayer, of the Stevens Institute of Technology, of New Jersey, has arranged the apparatus shown in the accompanying figure.

It consists of a gilt pith ball of 1 cm. radius, made of pieces of pith cemented together, and suspended at a distance of 364 cm. from the ceiling by a very fine silk fibre passed through a small staple driven into the ball. The ends of the fibres are attached to the ceiling at a distance of 52 cm. apart, and arranged so that the suspended ball can be raised or lowered, until it is at the same height as a brass ball, also of 1 cm. radius, supported on a glass rod, coated while hot with paraffin wax. A force of 1 dyne acting on the suspended ball deflects it through 13·3 mm., and, as 2° deflection was the maximum employed, the scale was inclined to the horizontal so as to coincide with the chord of an angle of 2°.

If a charge be given to the two small balls when in contact, and when therefore it will divide equally between them, the charge on either in *absolute electrostatic units* equals

$$D\sqrt{\frac{d}{1{\cdot}33}},$$

where d is the deflection in centimetres of the pendulum from the vertical, and D the distance in centimetres between the centres of the two balls.



To test the sensitiveness of the apparatus, the ball on the stand was placed at various distances from the suspended one, and the force between them observed. The law of the inverse squares was found to be verified with an error of less than 1 per cent. when D was over 5¼ cm. Next the gradual diminution of the deflection when the brass ball on the stand was in a fixed position was used to measure the rate of loss of charge, and it was found that the measured leakage to earth was proportional to the measured charges with a considerable degree of accuracy in several experiments, and with a maximum error of 20 per cent. in the most discordant experiments. Then the pendulum electrometer was used to measure the electric distribution over the surface of a cylinder, a proof plane being employed to convey the charge from different parts of the surface of the cylinder to the pendulum electrometer, and results were obtained closely agreeing with those obtained by Coulomb. Lastly, the potential of the large sphere was experimentally determined in absolute electrostatic units for different charges given to it.

NOTES.

WE are glad to learn that the President of the French Republic has conferred on Prof. Sylvester and Prof. Cayley the "Decoration d'Officier de la Légion d'Honneur." This honour has been granted in consequence of a request addressed to the French Minister of Foreign Affairs by the President and other members of the Academy of Sciences.

LORD RAYLEIGH has been elected a corresponding member of the Imperial Academy of Sciences in Vienna.

THE French Association for the Advancement of Science will hold its nineteenth meeting at Limoges from August 7 to 14. Various English men of science have been invited by the Bureau of the Association to attend the meeting, and they are asked to let their decision be known before July 1. Those of them who accept the invitation will be the guests of the Municipality of Limoges.

THE Queen has been pleased to approve of the grant of Civil List pensions to Miss Charlotte, Ruth, Margaret, and Rose,

daughters of the late Rev. M. J. Berkeley, F.R.S. A Civil List pension has also been granted to Mrs. Wood, widow of the Rev. J. G. Wood, the well-known popular writer on natural history.

DR. JAMES CLARK, M.A. (Edin.), Ph.D. (Tübingen), Royal Exhibitioner and Associate in Botany, Prizeman in Geology (Edinburgh University), has been appointed Professor of Natural History in the College of Agriculture, Downton, Salisbury. Dr. Clark has recently been employed on important work in the Natural History Department of the British Museum, and is the author of several papers on geology and biology.

A CHAIR of Mechanical Engineering is about to be established in connection with the University College of South Wales and Monmouthshire, Cardiff; and the authorities of the institution are already looking about for a suitable professor. A lectureship in mining engineering will shortly be founded at the same College, and electrical engineering is also to receive attention.

THE Annual Congress of the British Archæological Association will be held at Oxford in the second week of July.

AN important International Photographic Exhibition will be held in Vienna in April next year. The *Photographic News* says it is intended that only comparatively recent work, and that of the best kind, shall be shown. A jury of artists and photographers will decide as to the admission of pictures. The Exhibition will be held in the Imperial Austrian Museum of Art and Industry.

MR. THOMAS LAYTON, F.S.A., of Kew, who has for many years been engaged in forming a museum of the prehistoric antiquities of his district, has lent to the British Museum a fine series of bronze swords, spears, and axes, all found in the River Thames between Richmond and Battersea. The loan is shown in a case by itself.

A SCIENTIFIC and Industrial Exhibition was to be opened at Kazan on May 27. It will contain exhibits from Eastern Russia, Siberia, Central Asia, and the Caucasus, and promises to be of great interest to ethnographers.

DR. ADOLF STRUBELL, of Frankfort, who started on a journey of zoological research in India in March 1889, is now in Java making scientific collections, which he intends to present to the Senckenberg Museum of Frankfort.

THE celebration of the six hundredth anniversary of the foundation of the University of Montpellier has been most successful. All the great technical schools of Paris and the French provinces were represented, and deputations from many foreign Universities were present. The proceedings began on May 22, when there was a great reception in the University hall. M. Chancel, the Rector, welcomed the guests, and Prof. Tedenat sketched the history of the University and its most celebrated professors. On the following day M. Carnot arrived. The delegates of foreign Universities, followed by those of the great French schools, marched from the University to the Prefecture to be presented to the President of the Republic; and, if we may judge from a description by a correspondent of the *Times*, the procession must have been a remarkably interesting spectacle, the French and foreign professors being in robes of the most varied colours. The pavement and balconies along the route were crowded by men, women, and children. After the ceremony at the Prefecture the company proceeded to a park overlooking the town, commanding a view of the Cevennes on one side and the Mediterranean on the other. Several speeches were delivered under an awning. The Rector of the University thanked the President for having honoured the celebration by his presence. M. Croset gave a history of the University, and dwelt on the great trade of Montpellier in the Middle Ages, and its relations with the Arabs and Jews. Its most flourishing period, he said, was from the twelfth to the fourteenth century, and Petrarch spoke of it as a kind of ideal University. It made special progress in studies based on the observation of nature. The delegate of Bologna, the most ancient University represented, thanked M. Carnot for his reception of the foreign delegates. M. Bourgeois, Minister of Education, in a much-applauded speech, said the Government recognized the justice of the desire expressed by Montpellier and the other great schools to resume the name of University and the privileges associated therewith, and the question would shortly be discussed in the Chamber. We may specially note that the later proceedings included the presentation of an address by French men of science to Prof. Helmholtz, who represented the University of Berlin.

THE Königliche Physikalisch-Oekonomische Gesellschaft of Königsberg, one of the oldest societies of its kind, recently celebrated its centenary. It met first in Mohrungen, but in 1792 was amalgamated with the Economical Reading Institute of Königsberg, and thereafter bore its present name. In its earlier years it dealt chiefly with rural economy and agriculture. Later on, questions of natural science came more to the front, partly under the influence of Karl Ernst von Baer, the most illustrious name in the Society's annals. Still later, the Society had an anatomist of note among its members, Heinrich Rathke, who did good work in the same field as von Baer.

DR. T. A. HIRST, a former President of the Association for the Improvement of Geometrical Teaching, has presented to the Association, for its library, a valuable gift of forty volumes on geometry. The Association has also acquired by purchase an interesting collection of about twenty-five older text-books, including the "Treatise on Algebra" by Saunderson, the blind Lucasian Professor, and Stirling's "Methodus Differentialis."

ON Wednesday, May 21, a public meeting was held at the Mansion House "to promote the national work undertaken by the committee for testing smoke-preventing appliances." The Lord Mayor presided. Lord Derby proposed a resolution approving the objects of the committee. He thought that the diminution of smoke, and its necessary accompaniment dirt, was a matter which concerned everyone, except those who were fortunate enough to live away from great towns. Indifference was the real difficulty which they had to encounter, but in England anything which came to be recognized as a want was eventually supplied. The expenditure of fuel in creating dirt—for that was what it came to—was a waste of fuel itself, and the injury caused to property was not inconsiderable. He believed that more than three-fourths—he would say something like nine-tenths—of the smoke from collieries and factories was absolutely preventable, though some trouble and outlay would be required. Possibly more stringent legislation would be needed, but let them first try the experiment of enforcing the laws which they already had. Lord Howard of Glossop seconded and Prof. Chandler Roberts-Austen supported the resolution, which was carried unanimously. On the motion of Sir Henry Roscoe, M.P., seconded by Earl Fitzwilliam, and supported by Alderman Bowes (Salford), a resolution was passed in favour of the raising of a fund to meet the expenses of the work.

SOME interesting explorations have just been made in connection with the famous Adelsberg Cave. The Vienna Correspondent of the *Daily News* says that various citizens of Adelsberg, wishing to ascertain whether the Ottoker Cave, discovered a year ago at some distance from Adelsberg, was in any way connected with the great cave, followed the course of the subterranean river Poik. It was known that forty years ago a party of explorers had their progress barred by a large lake, and the present adventurers therefore carried with them a boat.

Having successfully crossed the body of water mentioned, they came to lofty galleries through which the river flowed. It was possible to walk on the banks of the stream, but at intervals it expanded into small lakes, and the boat had to be used. At last the gallery branched into two corridors, one of which the stream rendered impassable, while the other was high and quite dry. The boat was dragged up, and the party proceeded. After crossing a fourth lake, the largest they had met, they found that the Ottoker Cave had been reached. The journey through the galleries lasted six hours. The explorers saw that they had by no means penetrated to the remotest parts of the grotto, and there is evidently still a wide field for discovery.

ACCORDING to a telegram sent through Reuter's Agency from New York, a slight shock of earthquake was felt at Utica and at other points in the northern portion of New York State on May 25. The disturbance was felt more severely in Montgomery County. At Little Falls the shock was sufficiently strong to cause dishes and other similar articles to rattle, and subterranean rumblings were heard, while at Fort Hunter the buildings were so shaken that beds were moved and their occupants awakened. No damage was done.

ANOTHER telegram, sent through Reuter's Agency from Constantinople on May 26, tells of the destruction of an Armenian village by an earthquake. The village was Kayi, in the district of Refahie. Mineral springs spouted from the crevices made in the ground, and flooded the fields. There was no loss of life, as two days previously subterranean rumblings were heard, and cracks appeared in the ground, in consequence of which the Caimakan of the district ordered the inhabitants to leave the village.

ON Sunday last an influential meeting was held in Madrid, at the official residence of the Prime Minister, to prepare the way for the celebration, in 1892, of the four hundredth anniversary of the discovery of America by Columbus. The meeting selected a Grand Committee, which will act in concert with the Spanish Government and the Royal Commission appointed some time ago, and presided over by the Duke of Veragua, a lineal descendant of Columbus, and the present Minister of Public Works. The Madrid Correspondent of the *Daily News* says that the most eminent among Spanish statesmen, as well as artists, writers, men of science, and military men, will assist on the organizing committees. It is proposed that the centenary shall be celebrated, if possible, by an Exhibition at Madrid. Vigorous preparations are also being made at Genoa for the suitable commemoration of the same great event.

THE Danish Admiralty has ordered systematic hydrographical observations to be made all round the Danish coast. They began on May 1, and are to be continued regularly once a month on all lightships and on five movable stations. The object of these observations is to obtain detailed data concerning the ichthyological and meteorological conditions of the Danish seas. Special apparatus has been constructed by Captain Rung for the measurement of the percentage of salt in the sea-water.

WE learn from *Science* that, at a recent meeting of the American Meteorological Society in Washington, resolutions were adopted "favouring the recognition of the eminent services of American electricians by perpetuating their names in the nomenclature of electrical units." At the Electrical Conference to be held in America in 1892, it will be proposed that the name of Joseph Henry—or some modification of it—shall be given to the unit of self-induction, "he having been the first to investigate that phenomenon, and his investigations having been more complete than those of other electricians before or since."

THE temperature of snow at different depths has been investigated by Signor Chistoni. He finds that the variations in temperature of the lowest layer, next the ground, are extremely small, whilst the uppermost layer has often considerably higher temperature (as much as 10° C. at times). The temperature minimum of the air-layer next the snow was always lower than that of the uppermost snow-layer, while an air-layer about 20 inches above the snow had a higher temperature than the layer 1·2 inches above the snow.

DR. J. HANN communicated to the Academy of Sciences at Vienna, on April 17, a memoir on the high air-pressure of November 12–24, 1889, in Central Europe, together with remarks upon high-pressure areas generally. As this anticyclone lay nearly the whole time over the Alpine district, observations could be made at various stations up to a height of above 10,000 feet. Dr. Hann found (1) that the high pressure extended to more than three kilometres above sea-level; (2) that at this altitude the relative warmth was as great as at a height of one kilometre, while the usual depression of temperature of winter anticyclones was limited to a few hundred feet above the earth; (3) that great dryness prevailed in the higher strata of the air. The author finds in these results a cogent reason for concluding that in barometrical maxima the air has a descending motion, and that the conditions of pressure are not explained by conditions of temperature, but are a consequence of the movement of the air. The temperature conditions are dependent upon the movements of the anticyclones, in the same way as the dryness of the air, and the clearness of the sky. In another section of the paper he investigates the vertical distribution of temperature in a barometrical minimum. During one instance, on October 9–10, 1889, he found that the temperature on the summit of the Sonnblick was lower than during the barometrical maximum above quoted. Until the establishment of mountain stations, the temperature was assumed to be one of the chief causes of the form of motion of cyclones and anticyclones, but future inquiries must take into account that up to at least four or five kilometres the temperature of the centre of an anticyclone may be, and probably always is, higher than in the centre of a cyclone.

IN a recent number of the *Zeitschrift für Schul-Geographie*, Mr. H. Habenicht has written an article on the causes of the cyclones of the North Atlantic. The author points out that, if the globe were covered with water, the general circulation of the air would be very regular, without local depressions and steep barometric gradients, and he refers to the contrast of the systems prevailing, *e.g.* between the South Pacific and the North Atlantic. He finds the explanation primarily in the obstruction offered to the regular courses of the winds by the great continents to the east and west of the Atlantic; and, secondly, in the constant barometrical maxima over the continent in winter and in the neighbourhood of the Arctic regions.

THE Massachusetts Institute of Technology, Boston, has issued the twenty-fifth annual catalogue of its officers and students, with a statement of its courses of instruction and a list of its alumni. The courses of study include the physical, chemical, and natural sciences and their applications; pure and applied mathematics; drawing; the English, French, German, and other modern languages; history; political science; and international and business law. It is claimed that these studies and exercises are so arranged as to afford a liberal and practical education in preparation for active pursuits, and a thorough training for most of the scientific professions.

IN the entomological part of the forty-first Annual Report of the trustees of the New York State Museum of Natural History, lately published, reference is made to the statements which have been advanced as to the long imprisonment of beetles within furniture. The writer suggests that when such cases occur the condi-

tions may bring about a lethargic state, in which respiration and accompanying phenomena are almost or entirely suspended through the complete exclusion of air (a hermetic sealing) by the rubbing, oiling, varnishing, or other polishing which the furniture has undergone. As an instance of prolonged vitality, he quotes an extract from the third Report on the insects of New York, by Dr. Fitch. In this passage Dr. Fitch says:—"In 1786, a son of General Israel Putnam, residing in Williamstown, Mass., had a table made from one of his app'e-trees. Many years afterwards the gnawing of an insect was heard in one of the leaves of this table, which noise continued for a year or two, when a large, long-horned beetle made its exit therefrom. Subsequently, the same noise was heard again, and another insect, and afterwards a third, all of the same kind, issued from this table-leaf—the first one coming out twenty, and the last one twenty-eight, years after the tree was cut down." The evidence before Dr. Fitch convinced him that the insect was the longicorn beetle *Cerasphorus balteatus*, now known as *Chion cinctus* (Drury).

THE *American Naturalist* quotes from the *Salem Register* an extract from which it seems that the museum of the Peabody Academy of Science of Salem, Mass., has lately been enriched by a fine collection of objects illustrating the art and ethnology of Japan. This has been formed by Prof. Edward S. Morse, who some time ago spent several months in Japan. The catalogue of Japanese accessions enumerates 691 specimens, the most conspicuous objects being life-sized figures, representing different classes of the community. These models were all made for the museum, and are the best that have ever been brought to America. The collection also includes many fine old swords, sets of tools, and pictures illustrating various trades and professions.

SOME curious electrical phenomena were lately observed (according to a writer in the *Chemische Zeitung*) in a stearin and ceresin manufactory in Italy. One evening four vats of white ceresin (which is a paraffin got from ozokerit), containing about 500 kg. each, were being stirred to cool. When the point of solidification was nearly reached, the electric light of the place accidentally went out; and, to the surprise and alarm of the rather ignorant workmen, the mass of ceresin was observed to give pale sparks on the slightest motion. If the hand was brought near, loud sparks nearly two inches long were obtained. The phenomenon lasted over half an hour.

A VALUABLE collection of Tibetan medical works and drugs has been brought by M. Ptitsyn from Transbaikalia. He has also collected most interesting information as to the courses of study at the Buddhist *lamas*' University at the Gusinoie Ozero Monastery in Transbaikalia. The curriculum lasts ten years, the first four of which are devoted to the study of the Tibetan and Mongol languages, to religious service, and to practice in drawing and various handicrafts. The next three years are given to medicine. During the first of these three years the pupils learn by heart the five volumes of the chief Tibetan hand-books of medicine, and the names of the drugs. The next two years are given to the study of therapeutics and surgery. The students also visit the Urga High School to follow the courses of the more renowned Tibet *lamas*, who come to Urga on purpose. The eighth year is given to astronomy and astrology, and the last two to philosophy and theology. Medicine is studied only by those who wish to devote themselves to the medical profession, and the courses of astronomy, astrology, philosophy, and theology are followed only by the best pupils. The chief (printed) medical work of Tibet is the "Rodijachava," or "The Tale of the *Curkhan* Otochi (god of Medicine) about what formerly was," a copy of which was secured by M. Ptitsyn. The Tibet medical authorities recognize 101 fundamental diseases, and M. Ptitsyn gives the names of 429 elements of drugs used by the Buddhist physicians. He notices that of the 101 diseases only two (paralysis and a kind of influence of the planets) are attributed to a mythical origin, and that of the 429 drugs only three have a similar origin (the bones of a dragon, the horns and the skin of the unicorn). The remainder are chiefly herbs, seeds, fruits, roots, and flowers, and partly mineral matters. They are all bought in Chinese drug-shops, except quinine, which is bought in Russia. M. Ptitsyn was allowed to visit one of the drug-shops, and found all drugs kept in order in separate drawers. He has brought to St. Petersburg samples of 202 different drugs, which will be analyzed at the Medical Academy.

SOME sea-urchins are known to live in cavities in rock. And the diameter of the cavity is often wider than that of the entrance, so that the animal could not leave its home or be taken out without injury. On the French coast of Croisic (Lower Loire) may be seen thousands of urchins thus ensconced in the granite rock, which is rich in felspar and quartz. The animals, it is not doubted, make and widen the holes for themselves; but the question how has not been satisfactorily answered. Chemical solution of the rock seems excluded, considering both the nature of the latter, and also that no acid which could be thus used has been proved to exist in the urchin. The matter has been studied lately by M. John, and in an inaugural dissertation (*Arch. f. Naturges.*) he explains the effects by mechanical action. With the so-called "lantern of Aristotle" the animal probably bites the rock; the sucker feet are also attached, and a rotatory motion is imparted to the body, the prickle points, with the lantern, gradually wearing down the surface. These cavities afford a shelter to the urchins against the action of the waves. An attempt is made to conceal them by means of mussel and other shells. The rocks in which the cavities occur are in general thickly covered with calcareous Algæ. It has been thought that possibly these decompose the rock, and so facilitate the work of the urchins. M. John, however, finds no such chemical relation, but atmospheric agencies, he considers, may help the work of boring. A number of other animals are known to penetrate rock, and it is supposed that they do it also in a mechanical way. Recently, M. Forel described to the Vaudois Society of Natural Sciences how in the hard limestone of Constantine, Algiers, *Helix aspera* was found in holes 4 to 5 inches in depth.

IT has been hitherto impossible, by the most careful and subtle methods, to produce absolutely pure water. Such water, it is thought, would have no conductivity for the galvanic current; but, as a matter of fact, there is always a measurable conductivity, which, in glass-vessels *e.g.*, gradually grows from day to day, through glass being dissolved. It has been lately observed by Herr Pfeiffer (*Wied. Ann.*) that water purified as much as possible, and standing only a short time in contact with the air, showed next day a continuous decrease of conductivity, which gradually disappeared, giving place to the normal unavoidable increase. After testing various explanations of this by experiment, he came to the conclusion that the true explanation is micro-organisms coming into the water, and absorbing the conducting substances present. On this assumption such organisms would appear to have an almost absolute power of absorption, something like that of sulphuric acid for water-vapour.

MR. L. UPCOTT GILL has issued the first part of a volume entitled "British Cage Birds," by Mr. R. L. Wallace. The work will be completed in 15 parts, and will contain directions for breeding, rearing, and managing the various British birds that can be kept in confinement. Mr. Gill has published also the first part of "The Canary Book," by the same author. Both works are illustrated with coloured plates and wood-engravings.

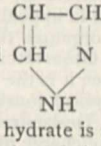
IN the new number of the *Internationales Archiv für Ethnographie*, Hermann Strebel continues his paper on a peculiar kind of stone object, found in Mexico and Central America, which is generally supposed to have been used in connection with the sacrifice of human victims. It is fashioned in the shape of a yoke or bow, and enriched with sculpture. Herr Strebel shows that it was worn as a mark of honour by persons of high rank. The sculpture was, he believes, of a symbolical character. Dr. L. Lewin, of Berlin, contributes an interesting paper on betel-chewing, adding fresh information to that which he brought together in a previous article. M. de Clercq gives some notes (in Dutch) relating to New Guinea, and Herr H. Vos deals with the area of anthropophagy on the Asiatic continent.

THE Leicester Literary and Philosophical Society has issued the third part of the second volume of its Transactions (new quarterly series). Among the contents are the abstract of an address, by Prof. Flower, on pygmies; a paper on spiders, by the Rev. W. Agar; and a contribution to the pterylography of birds' wings, by W. P. Pycraft.

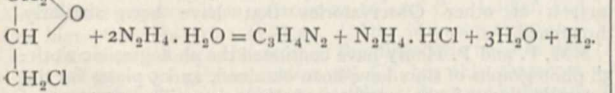
WE have received Part 20 of Cassell's "New Popular Educator." It is carefully illustrated, and contains maps of Eastern Australia and New Zealand.

MR. JOHN WHELDON has issued a catalogue of zoological works, and papers, transactions, and journals relating chiefly to anatomy and physiology. A catalogue of works on astronomy, magnetism, and meteorology has been issued by Messrs. Dulau and Co.

PYRAZOL, $C_3H_4N_2$, the fundamental base of a rapidly growing series of compounds, has been synthesized by Prof. Balbiano, of Messina, from epichlorhydrin and the recently isolated hydrazine hydrate (*Berichte*, No. 8, p. 1103). Pyrazol is a pentagonal closed chain compound, which may be represented



The reaction between epichlorhydrin and hydrazine hydrate is a somewhat violent one, a considerable amount of heat being generated. It appears to take place in the manner indicated by the following equation:—



Equal weights of epichlorhydrin and hydrazine hydrate, which latter is a liquid boiling at 119° C., are cautiously mixed in a flask, to which is immediately fitted a reflux condenser. The reaction completes itself in 3–4 minutes without any external application of heat. When the reaction is at an end, and the last trace of the epichlorhydrin has disappeared, the flask and contents are heated in a water-bath for 25–30 minutes. After allowing to cool, a quantity of zinc chloride equal to that of either of the reagents is added, in order to facilitate the splitting off of water. The whole is afterwards again heated for an hour over the water-bath. The yellow waxy mass so obtained is then mixed with 300–400 c.c. of water for every 10 grams of either reagent employed, and the mixture distilled in steam. Pyrazol and ammonia distil over in the steam together, and, in order to separate the pyrazol, the distillate is treated with a solution of mercuric chloride, which produces a mixed precipitate of the mercury compound of pyrazol and mercurammonium chloride. The precipitate is suspended in water, decomposed with sulphuric acid, and the solution of pyrazol hydrochloride and sal-ammoniac evaporated to the crystallizing point on the water-bath. The residue is then decomposed by potash, and the pyrazol extracted by ether. Upon evaporation, pyrazol is obtained as a mass of hard colourless needles. The crystals of pyrazol are readily soluble in cold water, with production of a neutral solution. They possess an odour very similar to that of pyridine. They melt to a colourless liquid at 69·5°–70°, and the liquid boils at 186°–188°. The aqueous solution gives a white precipitate with mercuric chloride solution and with an ammoniacal solution of silver nitrate. In all these respects the pyrazol thus prepared from epichlorhydrin and hydrazine hydrate is identical with a substance of the formula $C_3H_4N_2$ prepared some little time ago by Buchner by heatingthe methyl ether of acetyl ene-dicarboxylic-diazoacetic acid. A concentrated hydrochloric acid solution of pyrazol gives, with platinum chloride, a precipitate of lustrous yellowish-red needles of pyrazol-platinate $(C_3H_4N_2 . HCl)_2PtCl_4 . 2H_2O$. When this salt is heated to 205°, the colour changes to straw-yellow, and remains permanent up to 250°. The yellow substance is a definite compound, insoluble in water, and possessing the composition $\begin{matrix} C_3H_3N_2 \\ C_3H_3N_2 \end{matrix}\!\!>\!PtCl_2$. It is formed from pyrazol-platinate by loss of two molecules of water and four molecules of hydrochloric acid.

THE additions to the Zoological Society's Gardens during the past week include two Beatrix Antelopes (*Oryx beatrix* ♂ ♀) from Arabia, presented by Colonel Ross; a North African Jackal (*Canis anthus*) from North Africa, presented by Captain Hay; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mr. C. Armstrong King; a Vociferous Sea Eagle (*Haliaëtus vocifer*), a White-crested Tiger-Bittern (*Tigrisoma leucolophum*) from West Africa, presented by Mr. J. B. Elliot; a Mexican Guan (*Penelope purpurascens*) from Mexico, presented by Mr. J. W. Dawe; two Common Kingfishers (*Alcedo ispida*), British, presented by Mr. T. E. Gunn; a Tawny Owl (*Syrnium aluco*), British, presented by the Hon. C. Parker; two All-green Snakes (*Philodryas viridissimus*), two Natterer's Snakes (*Thamnodynastes nattereri*), two Merrem's Snakes (*Liophis merremi*), a Chequered Elaps (*Elaps lemniscatus*) from South America, presented by Mr. A. C. Derrett; a Barraband's Parrakeet (*Polytelis barrabandi*) from New South Wales, a Brush Turkey (*Talegalla lathami*) from Australia, deposited; an Eland (*Oreas canna* ♂), bred in France, two Diademed Jays (*Cyanocitta diademata*) from Mexico, two Temminck's Tragopans (*Ceriornis temmincki* ♂ ♀) from China, purchased; two Persian Gazelles (*Gazella subgutterosa* ♂ ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on May 29 = 14h. 29m. 9s.

Name.	Mag.	Colour.	R.A. 1890. *Remarks.*	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 3846	—	—	14 14 45	+ 4 26
(2) D.M. + 15° 2758 ...	5	Reddish-yellow.	14 40 45	+15 35
(3) ο Boötis	4	Whitish-yellow.	14 40 6	+17 26
(4) ζ Boötis	3	White.	14 35 54	+14 12
(5) χ Cygni	Var.	Very red.	19 46 20	+32 38

(1) There are no very bright nebulæ which come to the meridian near 10 o'clock during this week, but the one given is probably one of the brightest. The General Catalogue description is: "Bright, pretty large; round; pretty suddenly brighter in the middle; barely resolvable (mottled as if with stars); a 12th magnitude star in *nf* quadrant." The spectrum has not been recorded.

(2) According to Vogel and Dunér this star has a magnificent

spectrum of Group II. All the bands 1–9 are plainly visible; they are wide and dark throughout the whole length of the spectrum. The chief observations required of such a star as this are direct comparisons with the bright carbon flutings, as their existence in stars of the 2nd group is still not generally accepted, although Dr. Copeland demonstrated it most conclusively in the so-called "Nova" Orionis. Our ideas of the constitution of this class of stars must turn almost entirely on this point; if the bright flutings exist, the stars, like comets, must consist of discrete masses.

(3) This is a star of the solar type (Vogel). The usual observations are required.

(4) The spectrum of this star is one of Group IV. The usual additional observations are required.

(5) This highly interesting variable will reach a maximum on May 30. The magnitude at maximum varies from 4 to 6·5, whilst that at minimum is below 13. The change of luminosity is therefore enormous, and it is obvious that many of the explanations offered for different kinds of variables, such as variation of spotted area, are quite insufficient for a case like this. The period is about 406 days, but it appears to be shortening. The spectrum is a magnificent one of Group II., and near the maximum last year Mr. Espin noted the presence of bright lines, amongst which the line D_3 was very bright. In future observations, the bright carbon flutings should also be carefully examined, as it seems very probable that, if they exist, they will brighten along with the lines of hydrogen and D_3. If the principal fluting, near *b*, be sufficiently bright, the 2nd maximum of the fluting may be bright enough to be measured. The collision theory of variability seems to explain this class of variable in every detail, even to the lengthening of the period, for the retardation which the secondary swarm would undergo at maximum must inevitably in time lengthen the period.

THE SPECTRUM OF COMET BROOKS (*a* 1890).—On the evenings of May 21, 22, and 23, I made some observations of this comet which may not be without interest. On the 21st the appearance of the comet was not unlike that of the Nebula in Andromeda, except that it was almost circular instead of elliptical in shape. The colour of the comet was whitish, and the nucleus was rather ill-defined. The spectrum was to a large extent continuous, but there were also unmistakable bright flutings. These were brightest in the nucleus, but they also extended faintly throughout the whole mass. Direct comparisons with the blue base of a spirit-lamp flame showed coincidences with all the flutings, except the bright one in the violet which is characteristic of hydrocarbons. The fluting near *b* was by far the brightest, and next in order of intensities came those near λ 474 and 564. The continuous spectrum extended from about D to a little beyond λ 474. On the 22nd the nucleus was much less central than on the previous evening, probably owing to further development of a short bushy tail. The spectrum, however, showed no obvious differences, except that the brightest fluting had slightly increased in intensity. On the 23rd the form and spectrum were practically the same as on the 22nd. The observations were made with a 10-inch refractor, but the comet was easily seen in the 3-inch finder.

The comet had obviously got beyond the earlier temperature stages before I observed it, and it will be highly interesting to notice if the further changes indicated by Prof. Lockyer's discussion of cometary spectra (see p. 20) take place. These will be most obvious in the faintest band (λ 564) owing to the superposition of the bright flutings of manganese and lead. Changes of the form or wave-length of this band should therefore be particularly noted in further observations. It is, of course, desirable that the observations should be made independently by more than one observer. In my observations of May 21 I was very much struck by the resemblance of the comet to the Nebula in Andromeda, both in form and colour, and in spectrum.

On the 27th I again observed the comet, but saw no decided differences, either in its appearance or spectrum.

A. FOWLER.

NEW VARIABLE STAR IN CYGNUS.—Prof. Pickering, of Harvard College, notes in *Astronomische Nachrichten*, No. 2968, that a study of the spectra of the fainter stars is now in progress with the 8-inch Draper telescope. An examination by Mrs. Fleming of photographs taken with small dispersion led to the discovery that the star D.M. + 48°·2940 whose approximate place for 1900 is in R.A. 19h. 40m. 8s., Decl. + 48° 32′ gave a spectrum resembling that of Mira Ceti and other variables of long period. A photographic chart was made, and on comparison with the photographs previously taken of this region proved conclusively that the star is a variable. The photographs compared are of three kinds: (1) trails in which the telescope was at rest and the brighter stars formed lines by their diurnal motion; (2) charts in which the stars formed circular images; (3) spectra formed by placing a prism in front of the object-glass. From the various photographs of the spectrum of this star, it appears that on September 23, 1887, the hydrogen lines *h* and G are shown bright; the star was then estimated as of the 8th magnitude. On June 16, 1888, magnitude being estimated as 9, the spectrum was faintly visible and apparently continuous, but no bright lines were seen. On September 7 of the same year, G was well seen, and *h* was barely visible, the magnitude being again estimated as 8. There is no doubt, therefore, that this is another example of that group of variable stars that exhibit bright hydrogen lines in their spectra when at a maximum.

PARIS OBSERVATORY.—Admiral Mouchez, the Director of this Observatory, has issued his Report for the year 1889. An account of the resolutions adopted last September by the International Committee for the execution of the map of the heavens is given. It is also noted that the building is completed which is to receive in two or three months the *coudé* equatorial, 0·60 metre aperture and 18 metres focus. M. Lœwy has supervised the details of the installation of this instrument, which will replace, with some advantage to Paris Observatory, the instrument 0·74 metre aperture first intended for it. This latter telescope is attached to Meudon Observatory, and will find there atmospheric conditions more favourable for the use of its great optical power than at Paris.

The electric light has been installed for the lighting of the two *coudé* equatorials and the meridian circle.

For some years, almost the whole force of the Observatory has been engaged in re-observing on the meridian the stars in Lalande's catalogue. This work was commenced about twenty-five years ago, and on account of it other branches of astronomy have had to be neglected. It is, however, nearly completed, and Admiral Mouchez proposes to the Council that a regular spectroscopic service should be instituted. Up to now, spectroscopy has only existed nominally at Paris Observatory, and in appealing to the administration for the necessary funds to organize this new department it is very truly observed that no Observatory can well dispense with spectroscopic accessories, since it is the study of this branch of astronomy that enables the physical constitution of the heavenly bodies to be determined. M. Deslandres, already known for his spectroscopic works, will take charge of this new department.

A Commission has been appointed to investigate the inconveniences that would arise from the laying of the proposed railway line at a distance of about 150 metres from the Observatory. The Report of the Commission, when ready, will have some interest at other Observatories that have been similarly threatened.

MM. P. and P. Henry have continued the photographic work: 38 photographs of stars have been obtained, and 5 plates for the determination of the parallax of Victoria. The constant of photographic refraction has been determined, and lunar photographs having a diameter of 40 cm. have been obtained by direct enlargement.

Many observations have been made of comets. M. Bigourdan has made 300 complete measures of nebulæ; the major planets and the asteroids have received as much attention as the continued bad weather permitted; and, leaving out of consideration the absence of spectroscopic work, which another year may see remedied, the Report is altogether a satisfactory one.

ON THE PARALLAX OF DOUBLE STARS.—At the March meeting of the Royal Astronomical Society, Mr. Arthur A. Rambant directed the attention of astronomers to a paper in which he pointed out the relation connecting the parallax and the relative velocity of the components of a double star with the period and angular elements of its orbit, and discussed the possibility of determining the distance by means of spectroscopic observations of this velocity. The photographs of stellar spectra recently obtained by Prof. Pickering in America and Prof. Vogel at Potsdam are in point of accuracy so far in advance of direct eye observations of motion in line of sight that they seem to demonstrate the possibility of applying the method described to the determination of parallax, and the author shows how the

parallax (π) of a star can be immediately deduced if its velocity (V) in miles per second in the line of sight has been determined by observation. The advantages to be expected from spectrographic observations of double stars for which πV is greater than 0·1 are shown to be :—

(1) An independent check on the parallax where this has been determined trigonometrically.

(2) A determination of the parallax where, owing to its smallness, the trigonometrical method fails.

(3) A determination of the sign of the inclination which will remove the ambiguity attaching to the situation of the orbit.

It is to be hoped that astronomers who have the requisite instruments for this kind of observation may be induced to take up what appears to be a promising field of work.

TURIN OBSERVATORY.—We have received various publications from the Observatory of the Royal University of Turin. Amongst them we find convenient ephemerides of the sun and moon for 1889 and for 1890 calculated for the horizon of Torino by Señors Porro and Aschieri respectively, and a note by the former observer on the total eclipse of the moon on January 28, 1888. The difference of longitude between the meridian circle at Turin Observatory and Milan Observatory has also been redetermined. The value found in 1823 was 5m. 58·85s., and the value now found is 5m. 58·736 ± 0·006 ; thus the difference between the two observations is only 0·11s., although the former was not made by telegraphy.

A CONTRIBUTION TO THE ETIOLOGY OF DIPHTHERIA.[1]

THE microbe, which was first described by Klebs (at the Wiesbaden Congress in 1883), then isolated and grown in artificial cultures by Löffler (*Mitth. aus dem K. Gesundheitsamte*, vol. ii.) from human diphtheritic membrane, was shown by this observer to act virulently on various animals. The Klebs-Löffler bacillus—by which name the diphtheria microbe is known—is the one with which also Roux and Yersin (*Annales de l'Institut Pasteur*, ii., 1888, No. 12) obtained positive results on guinea-pigs.

In the Reports of the Medical Officer of the Local Government Board for 1888-89 and 1889-90, I have shown that there occur in diphtheritic membranes two species of bacilli, very similar in morphological respects, and also in cultures on serum and on agar, but differing from one another in this, that one species, Klebs-Löffler bacillus No. 1, is not constant in diphtheritic membranes, does not grow on solid gelatine at 19°–20° C., and does not act pathogenically on animals ; the other species, Klebs-Löffler bacillus No. 2, is constant in diphtheritic membranes, in fact is present even in the deeper layers of the membranes in great masses and almost in pure culture, acts very virulently on animals, and grows well on gelatine at 19°–20° C. Löffler, and after him other observers (Flügge, "Die Mikroorganismen," 1886), considered it as a character of the diphtheria bacillus that it does not grow on gelatine below 22° C., but this character, though true of the Klebs-Löffler species No. 1, does not appertain to the diphtheria bacillus species No. 2. In fact, there is no difficulty in obtaining pure cultures of this bacillus on gelatine if a particle of diphtheritic membrane be taken and well shaken in two or three successive lots of sterile salt solution, and from the last lot plate cultivations on gelatine are made. In this way I have obtained the diphtheria bacillus in great numbers of colonies and in pure culture. Zarniko (*Centralbl. f. Bakteriol. u. Parasit.*, vol. vi., 1889, p. 154) and Escherich (*ibid.*, vol. vii., 1890, p. 8) both state that the diphtheria bacillus does grow on gelatine below 20° C.

This bacillus diphtheriæ acts very virulently on guinea-pigs on subcutaneous inoculation ; at the seat of the injection a tumour is produced, which in its pathology and in microscopic sections completely resembles the diphtheritic tissue of the human. In human diphtheria the diphtheria bacillus is present only in the diphtheritic membrane, but neither in the blood nor in the diseased viscera ; the same holds good for the experimental guinea-pigs. In subcutaneous inoculation with artificial culture, though it causes in these animals acute disease and death—the lungs, intestine, and kidney are greatly congested—the diphtheria bacillus remains limited to the seat of inoculation. It was for these reasons that Löffler concluded that in diphtheria the diphtheritic membrane alone is the seat of the multiplication of the diphtheria bacillus, and that here a chemical poison is produced, which absorbed into the system causes the general diseased condition and eventually death. Roux and Yersin have then separated from artificial broth cultures the bacilli and the chemical products, and, by the injection of these latter alone into guinea-pigs, have produced a general effect. I have in this year's Report to the Medical Officer of the Local Government Board (1889-90) shown that in these experiments of injection of cultures into guinea-pigs, an active multiplication of the diphtheria bacilli at the seat of inoculation can be demonstrated by culture experiments ; from the local diphtheritic tumour and the nearest lymph glands the diphtheria bacilli can be obtained in pure culture on gelatine.

On various occasions during the last three years information has reached me by Health Officers (Dr. Downes, Mr. Shirley Murphy, Dr. Thursfield) as to a curious relation existing between a mysterious cat disease and human diphtheria in this manner, that a cat or cats were taken ill with a pulmonary disease, and while ill were nursed by children, and then these latter sickened with well-marked diphtheria. Or children were taken ill with diphtheria, and either at the same time or afterwards the cat or cats sickened. The disease in the cat was described as an acute lung trouble ; the animals were quiet, did not feed, and seemed not to be able to swallow ; in some cases they recovered, in others they became emaciated, while the lung trouble increased, and ultimately they died. In one instance—in the north of London, in the spring, 1889—this cat malady, occurring in a house where diphtheria soon afterwards appeared amongst the children, was of a widespread nature ; a veterinary surgeon—Mr. Daniel—informed me that at that time he had several patients amongst cats affected with the disease, consisting in an acute catarrhal affection, chiefly of the respiratory passages. He furnished me with two such animals : one that after an illness of several weeks had died, another that was sent to me in a highly emaciated state, affected with severe broncho-pneumonia ; this animal was paralyzed on the hind limbs. In both instances the *post-mortem* examination showed severe lung disease, broncho-pneumonia, and large white kidneys due to fatty degeneration of the entire cortex. A similar condition is met with in the human subject in diphtheria. Further, I received from Dr. Thursfield, of Shrewsbury, the body of a cat that had died after a few days' illness from pneumonia in a house in which children were ill with diphtheria ; another cat in the same house that became next ill with the same lung trouble also succumbed. The *post-mortem* examination of the animal that I received showed severe broncho-pneumonia and large white kidneys, the entire cortex being in a state of fatty degeneration.

Subcutaneous inoculations of cats were carried out with particles of fresh human diphtheritic membranes and with cultures of the diphtheria bacillus (Report of the Medical Officer of the Local Government Board, 1889-90) ; hereby a local diphtheritic tumour was produced at the seat of inoculation, and a general visceral disease ; in the cases in which death followed after a few days the lungs were found much congested ; when death followed after one or more weeks, the lungs showed broncho-pneumonia and the kidneys were enlarged and white, the cortex being in a state of fatty degeneration ; if the disease in the animals lasted beyond five to seven days, both kidneys were found uniformly white in the cortex ; if of shorter duration, the fatty degeneration was sometimes only in patches. Although in these experiments the bacillus diphtheriæ was recoverable by cultivation from the diphtheritic tumour at the seat of inoculation, there were no bacilli found in the lungs, heart's blood, or kidney, and the conclusion is justified that, just as in the human diphtheria and in the diphtheria produced by subcutaneous inoculation in the guinea-pig, so also in these experimental cats the visceral disease must be a result of the action of a chemical poison produced by the diphtheria bacillus at the seat of inoculation.

From this it is seen that the similarity between the artificial disease and the natural disease in the cat is very great, and the question that presents itself is, In what manner does the animal receive or give the diphtheritic contagium in the natural disease? The natural disease in the cat is in its symptoms and pathology a lung disease, and it is reasonable to suppose from analogy that the lung is the organ in which the diphtheritic process in the cat has its seat. The microscopic examination of the diseased lung

[1] Paper read before the Royal Society by Dr. E. Klein, F.R.S., on May 22. This research was undertaken for the Medical Department of the Local Government Board, and was communicated to the Royal Society with the permission of the Medical Officer.

of cats that died from the natural disease bears this out, the membrane lining the bronchi in the diseased portions of the lobules presenting appearances which in microscopic character coincide with the appearances in the mucous membrane of the human fauces, pharynx, or larynx in diphtheria. But the correctness of the above supposition, that diphtheria has its seat in the lung of the cat naturally diseased, was proved by direct experiment. Broth culture of the bacillus diphtheriæ was introduced into the cavity of the normal trachea without injuring the mucous membrane. The animals became ill with acute pneumonia, and on *post-mortem*, two to seven days after, there was found extensive pneumonia, and fatty degeneration of the kidney. The bronchi, infundibula, and air-cells of the inflamed lobules were found occluded by, and filled with, exudation, which under the microscope bears a striking resemblance to human diphtheritic membranes, and in the muco-purulent exudation in the large bronchi and trachea the diphtheria bacilli were present in large numbers.

During the last ten or twelve years certain epidemics of diphtheria have occurred which were traced to milk, but the manner in which that milk had become contaminated with the diphtheritic virus could not be demonstrated, although the evidence as to the milk not having been directly polluted from a human diphtheria case was very strong. The epidemic of diphtheria that prevailed in the north of London in 1878, investigated by Mr. Power for the Local Government Board, then the epidemic that occurred in October 1886 at York Town and Camberley, the epidemic in Enfield at the beginning of 1888, and in Barking towards the autumn of 1888, were epidemics of this character. Mr. Power, in his Report to the Local Government Board on the York Town and Camberley outbreak, states (p. 13) that a veterinary surgeon had certified that the cows from whom the infected milk was derived were all in good health, but that two of the cows showed "chaps" on their teats, and he adds that even two or three weeks after the epidemic had come to an end —the use of milk having been in the meanwhile discontinued— he saw at the farm one cow which had suffered chapped teats. At Enfield a veterinary inspector had also certified that the cows were in good health; but at Barking the veterinary inspector found sores and crusts on the udder and teats of the cows.

I have made experiments at the Brown Institution on milch cows with the diphtheria bacillus, which appear to me to throw a good deal of light on the above outbreaks of diphtheria.

Two milch cows[1] were inoculated with a broth culture of the diphtheria bacillus derived from human diphtheria. In each case a Pravaz syringeful was injected into the subcutaneous and muscular tissue of the left shoulder. On the second and third days there was already noticed a soft but tender swelling in the muscle and the subcutaneous tissue of the left shoulder; this swelling increased from day to day, and reached its maximum about the end of the week; then it gradually became smaller but firm. The temperature of both animals was raised on the second and third day, on which days they left off feeding, but after this became apparently normal. Both animals exhibited a slight cough, beginning with the eighth to tenth day, and this gradually increased. One animal left off feeding and ruminating on the twelfth day, "fell in" considerably, and died in the night from the fourteenth to fifteenth day; the other animal on the twenty-third to twenty-fourth day left off taking food, "fell in" very much, and was very ill: it was killed on the twenty-fifth day.

In both animals, beginning with the fifth day, there appeared on the skin of the udder, less on the teats, red raised papules, which in a day changed into vesicles, surrounded by a rim of injected skin; the contents of the vesicles was a clear lymph, the skin underneath was much indurated and felt like a nodule; next day the contents of the vesicle had become purulent, *i.e.* the vesicle had changed into a pustule; in another day the pustule dried into a brownish-black crust, with a sore underneath; this crust became thicker and larger for a couple of days, then became loose, and soon fell off, a dry healing sore remaining underneath. The whole period of the eruption of papules, leading to vesicles, then to pustules, and then to black crusts, which, when falling off, left a dry healing sore behind, occupied from five to seven days. The eruption did not appear in one crop: new papules and vesicles came up on the udder of one cow almost daily between the fifth and eleventh day after inoculation, in the other cow between the sixth and tenth day; the total number of vesicles in the fomer cow amounted to about twenty-four on the udder, four on the teats; in the latter they were all on the udder, and amounted to eight in all. The size of the vesicles and pustules differed: some were not more than $\frac{1}{4}$th of an inch, others larger, up to $\frac{1}{2}$-$\frac{3}{4}$ of an inch in diameter; they had all a rounded outline, some showed a dark centre. From one of the above cows on the fifth day milk was received from a healthy teat, having previously thoroughly disinfected the outside of the teat and the milker's hand; from this milk cultivations were made, and it was found that thirty-two colonies of the diphtheria bacillus without any contamination were obtained from one cubic centimetre of the milk.

Unlike in the human, in the guinea-pig and in the cat the diphtheria bacillus passed from the seat of inoculation into the system of the cow; this was proved by the demonstration of the diphtheria bacillus in the milk. But also in the eruption on the udder, the presence of the diphtheria bacillus was demonstrated by microscopic specimens and particularly by experiment. With matter taken from the eruption—vesicles and pustules—of the udder, two calves were inoculated into the skin of the groin; here the same eruption made its appearance: red papules, rapidly becoming vesicular, then pustular, and then became covered with brown-black crusts, which two or three days after became loose and left a dry healing sore behind. More than that, the calves that showed this eruption after inoculation became affected with severe broncho-pneumonia and with fatty degeneration of the cortex of the kidney. In the two cows above mentioned, on *post-mortem* examination, both lungs were found highly congested, œdematous, some lobules almost solid with broncho-pneumonia in the upper lobes and the upper portion of the middle or lower lobe respectively; the pleural lymphatics were filled with serum and blood. Hæmorrhages in the pericardium and lymph glands, and necrotic patches were present in the liver. At the seat of inoculation there was in both cases a firm tumour consisting in necrotic diphtheritic change of the muscular and subcutaneous tissue. In this diphtheritic tumour continuous masses of the diphtheria bacillus were present; their gradual growth into and destruction of the muscular fibres could be traced very clearly.

It appears then from these observations that a definite disease can be produced in the cow by the diphtheria bacillus, consisting of a diphtheritic tumour at the seat of inoculation with copious multiplication of the diphtheria bacillus, a severe pneumonia, and necrotic change in the liver; the contagious nature of the vesicular eruption on the udder and excretion of the diphtheria bacillus in the milk prove that in the cow the bacillus is absorbed as such into the system.

From the diphtheritic tumour, by cultivation, pure cultures of the diphtheria bacillus were obtained; a small part removed from the tumour with the point of a platinum wire, and rubbed over the surface of nutrient gelatine or nutrient agar, yielded innumerable colonies of the diphtheria bacillus without any contamination. In cultural characters in plate, streak, and stab cultures and in cover-glass specimens of such cultures, this cow diphtheria bacillus coincided completely with the human diphtheria bacillus, but in sections through the diphtheritic tumour of the cow a remarkable difference was noticed between it and the bacillus from the cultures; inasmuch as in the tissue of the tumour the masses of the microbe, both in the necrotic parts, as also where growing into and destroying the muscular fibres, were made up of filaments, granular threads, some of which possessed terminal oval or flask-shaped swellings. But that it was really the diphtheria bacillus was proved by culture experiments and by cover-glass specimens. In the latter, the transitional forms between typical diphtheria bacillus and long filaments with terminal knob-like swellings, with spherical or oblong granules interspersed here and there in the threads, could be easily ascertained. In the large number of cultivations that were made of the fresh tumour in both cows, the colonies obtained were all of one and the same kind, viz. those of the diphtheria bacillus; no contamination was present in any of the cultivations.

APPENDIX, *May* 20.—At the beginning of the month of April two cats died at the Brown Institution, after having been ill for several days, with symptoms like those of natural cat diphtheria. Between the beginning of April and the beginning of May, 14 cats became similarly affected, some more severely than others, and some died with the characteristic morbid change This epidemic, as it may be called, commenced with the illness of the

[1] The cows had been kept under observation previous to the experiment for ten days, and were in all respects perfectly normal.

first two cats about the end of March ; and the question arises as to how the disease originated in these two animals. No cats had been ill in their shed, and the two affected ones were healthy when received at the institution some weeks before. But during the latter half of March there were in the stables of the institution two milch cows ill with diphtheria induced by inoculation with the human diphtheria bacillus—in fact, the two cows already referred to. The diphtheria bacillus was found in the milk drawn from one of these animals on the fifth day after inoculation, and orders were given to the attendant that the milk of both cows was to be thrown away. This order was not obeyed, for part of the milk was given to the two cats above mentioned, and they sickened as described within a day or two afterwards. It ought to be mentioned that the man in attendance on the cows had also charge of the cats, but, in view of the fact that he was himself free from the disease, the possibility of his having conveyed it from the cows to the cats may be disregarded.

SOME NOTES FROM SOUTH AMERICA.

IN the course of a visit to the plains of South America, not far from Rosario de Santa Fe, in the Argentine Republic, lasting from September 1888 until March 1889, I was able to make some miscellaneous notes of more or less interest. From these I select the following :—

(1) *The Rhea, or South American Ostrich.*—The cock bird makes the nest, hatches the eggs, and takes care of the young birds. We had some (so-called) "tame" ostriches about the *estancia*. One day I came across the old cock in a nest that it had made in the dry weeds and grass. Its wings and feathers were loosely arranged, and looked not unlike a heap of dried grass ; at any rate the bird did not attract my attention until I was close on him. The long neck was stretched out close along the ground ; the crest-feathers were flattened ; and an appalling hiss greeted my approach. It was a pardonable mistake if for a moment I thought I had come across a huge snake, and sprang back hastily under this impression. This *might* be cited as an instance of (unconscious) "protective mimicry."

When a troop of these birds is alarmed while yet at a distance from the enemy, they run with their wings either close to the side in the normal position, or raised above the back into a narrow wedge that offers but little resistance to the air. But when a bird is somewhat pressed, it usually droops the wings loosely, almost trailing them. And when in danger of being caught by dogs, or struck by the *bolas* of a horseman, it begins to dodge and twist in a very curious manner, the wings assuming various positions. It would seem as though the wings, thus used, may help the bird to make its sudden halts and turns ; and also, when dogs are used in the chase, to baffle the attacks of these enemies. It was very curious to see the "tame" ostriches indulging in these freaks even when unpursued by the dogs of the *estancia*. The birds would rush straight along, turn and twist, contort their necks into very comical shapes, jump, and not unfrequently tumble over in their efforts to perform some unusually complicated evolution.

I may add that in the course of some years of "ostrich-running," my brother once observed a troop of these birds swim a river that crossed their path. He himself followed, and found that the river was really out of their depth ; they were not wading.

(2) *Snakes : the "Vivora de la Cruz."*— On October 6, 1888, we came across one of these common poisonous snakes, probably not long roused from its winter torpor. The dogs stood round it barking ; and it remained, threatening a strike. With its tail (and against the grass ?) it made a very distinct though not a loud burring, vibrating sound. This, my brother told me, was usual. Yet there is no kind of "rattle" on the tail.

At the end of March 1889, after I had returned to England, my brother killed a large *vivora de la cruz ;* and, observing that it appeared to be very thick in the body, he cut it open in order to examine it. Inside was a string of transparent bags, six or seven in number, connected with one another. In each of these could be seen a fully-formed young snake, about 6 inches long, as far as he could say without exact measurement, coiled up. Two of the bags he cut open ; and the young snakes, released, both threatened to strike anything that approached them, and made, though of course on a very small scale, the vibrating, burring noise with the tail.

(3) *The Intelligence (?) of Ants.*—One kind of small ant, if not more, makes large nests underground, in the shorter grass. A network of paths, clear of grass, about 2 inches wide near the nest, converge towards this latter ; being the roads by which the ants bring home forage. These paths are of all lengths from 10 yards up to 100 yards ; and, as one traces them further from the nest, they break up into smaller branches and are finally lost. As a general rule, one may say that streams of ants carrying leaves, buds, flowers, seeds, and other valuable odds and ends are always moving towards the nest, while empty-mouthed ants are meeting and passing them on their outward journey to the foraging grounds. Having, however, noticed a few burdened ants proceeding with great difficulty against the general stream of their burdened fellow-citizens, I tried the experiment of turning some of these carriers round when they had nearly reached home. The general conclusion I came to was that these ants did not then understand in what direction the nest lay, nor did they (as far as I could see) draw any conclusions from the fact that they now *met* the stream of carriers with which they had previously been travelling.

Thus, one ant, carrying a (relatively) huge burden, I reversed in direction when already near the nest. I then followed it for about 8 yards (or about 20 minutes of time as far as I can say) in its mistaken reversed course away from the nest. Though it met and collided with quantities of burdened ants, and was passed in the same direction as its own by unburdened ants only, it did not seem to take the hint. Its final return home was the result of accident, as far as I could tell ; it having got up "the right way round" after a severe fall.

Still it must be noticed that among the undisturbed ants very few went the wrong way.

I dug a hole in one of the paths, on several occasions. The hole was small ; and it was easy, though not so convenient, to go round by the side over the very short grass. Nevertheless it required the falling of very many ants into the hole, and the leaving of quite a pile of leaves there, before the stream learned to pass about about one inch to one or other side, and so to avoid the pitfall. Some ants even turned back ; and I left them carrying their burdens back to the foraging grounds again.

(4) *Grasses.*—I noticed two grasses concerning whose seeds a remark or two may be of interest.

(α) One is called "*Flechilla.*" Its seed bears a very sharp point ; and a number of hairs, turned back from the point, prevent the return of the seed from any body into which it has penetrated. Attached to the seed is always a piece of stem curiously twisted like rope. The whole answers somewhat to an arrow-head with barbed point and with shaft attached. My brother, whose observations extend over more than twenty years, tells me that this seed penetrates into the bodies of sheep, and is found in their internal organs. The spring lambs, which are left unshorn until summer is over, are especially troubled with the flechilla. When one of these animals dies and is skinned, it is very commonly found that quantities of these seeds have penetrated the skin, the heads being found in the flesh underneath ; and my brother has found them in the liver. It is believed that this is the cause of some deaths among the animals.

(β) Another remarkable grass is the "*Paja voladora.*" This grows in tufts, not unlike those of a small "Pampas grass." From slender stems there stand out still slighter branches, at the end of which are the seeds ; the whole, stem and seeds, having somewhat the appearance of a miniature fir-tree as regards shape, and having various lengths up to 2 feet or so. When ripe, these stems with the seeds blow bodily away in the first strong wind. I have seen them flying through the air, looking from afar rather like a dust-cloud against the sky ; and half rolling, half drifting, over the living grass of the plain, before the sudden onset of a *tormenta* (storm with wind). This drifting movement over the grass had a curiously bewildering effect on the eye. When the storm is over, the grass is found in drifts against the posts and wires of the fences ; these collections remind one strongly of snow-drifts.

On December 16 (or so), 1888, a terrible accident occurred on the railway between Candalaria and Guardia de la Esquina. A cutting had become filled with this *Paja voladora ;* and the engine set fire to it as it passed. However, thanks mainly to a suitable wind, the train got safely through. But in the afternoon of the same day the train re-passed in the opposite direction, and the cutting had in the meantime become filled again with

these seed-stems. The wind was, in this return journey, in such a direction as to favour the tendency of the burning grass to set fire to the carriages. They caught fire. About eight persons were totally consumed, hardly even bones being found to tell the tale; and eighteen escaped up the banks in a pitiable condition. I do not know how many of these are now alive.

W. LARDEN.

ON THE PROPERTIES OF LIQUEFIED GASES

M. E. MATHIAS has just published in the form of an inaugural thesis (Gauthier-Villars, Paris), an important investigation on the latent heat of vaporization of liquefied gases. The value of this coefficient for sulphurous acid, carbonic acid, and nitrous oxide was determined experimentally throughout a considerable range of temperature by the following method. The gases were first liquefied in a small copper cylinder, 9 cm. in height, 3 cm. in diameter, with walls 0·38 cm. in thickness. The cylinder was then weighed and introduced into an ordinary Berthelot calorimeter, and the liquefied gas was allowed to evaporate slowly, the pressure being constantly read off on a Bourdon gauge and regulated by means of two conical screw taps. The calorimetrical method employed was a null one (devised by the author), the heat absorbed by the evaporation of the liquid being compensated for by adding sulphuric acid of known strength to the water in the calorimeter, at such a rate as to keep its temperature approximately constant. The total amount of heat absorbed was thus easily determined, while the correction for cooling was reduced to a minimum. When necessary the laboratory was heated by means of regulated gas-burners, so that the liquid in the calorimeter and the surrounding atmosphere were at the same temperature in all cases. Seven experiments on liquid sulphurous acid between the temperatures of +5°·74 and +19°·95 gave values for L, the latent heat of vaporization, which may be expressed by the empirical formula—

$$L = (91{\cdot}87 - 0{\cdot}384t - 0{\cdot}000340t^2)\ \text{Cal.}$$

Nineteen experiments on liquid carbonic acid between +6°·65 and +30°·82 may be expressed by the formula—

$$L^2 = [117{\cdot}303\ (31 - t) - 0{\cdot}466\ (31 - t^2)]\ \text{Cal.}$$

The numbers obtained afford a satisfactory verification of Clapeyron's formula, as calculated from constants previously determined.

Owing to the great difficulty of obtaining nitrous oxide free from nitrogen, the results obtained with this gas can only be regarded as qualitatively correct. But the graphic representation of fifteen experiments, performed between the temperatures of +5°·37 and +34°, show that the curve representing the variation of the latent heat with the temperature is exactly of the same form for nitrous oxide as for carbonic acid. In both cases the tangent to the curve at the critical point is rigorously perpendicular to the temperature axis. We may from this conclude that at the critical point L is rigorously equal to zero, and hence from Clapeyron's formula that the specific volume of the liquefied gas and its saturated vapour are rigorously equal, a fact questioned lately by Cailletet and Colardeau. It follows, moreover, from the thermodynamical equation—[1]

$$m' = m + dL/dt - L/T,$$

where m' is the "specific heat of the saturated vapour"—that at the critical point,

$$m' = -\infty.$$

Now at the temperatures at which experiments have been made on ordinary liquids (water, ether, acetone, &c.), m', though negative, was found to increase with rise of temperature; but since we may conclude from these experiments that near the critical point it will decrease, it follows that it must at some intermediate temperature pass through a maximum. It follows also that if m', while increasing, pass through a zero value, that it will pass through a second zero value in the opposite sense. As m' for carbonic acid and nitrous oxide is negative and decreasing between −50° and +30°, if a zero value exist for these gases, it must be at a very low temperature. In the case of sulphurous acid, the results obtained were shown to confirm certain formulæ given by Bertrand in his "Thermodynamique," and applicable to saturated vapours at temperatures much below the critical point. The memoir as a whole is masterly.

1 See Verdet, "Théorie Mécanique de la Chaleur," i. p. 258.

NOTES ON INDIAN INSECT PESTS.

THE Government of India has evidently begun to realize the importance of the study of injurious insects, and the methods of combating them. Some time ago, Mr. E. C. Cotes, of the Indian Museum, published the first two numbers of "Notes on Economic Entomology," dealing respectively with the wheat and rice weevil in India, and with insecticides and the methods of applying them. This series has been discontinued, and its place has been taken by "Notes on Indian Insect Pests."

The first number of the new series contains notes on the Rhynchota, by Mr. Atkinson, the most detailed of which deals with the rice sapper (*Leptocorisa acuta*). These insects settle on the rice ear, sometimes to the number of ten on one ear, and, extracting the milky juice of the grain, leave the husk dry. Unfortunately, nothing is known of the life-history of this pest. Mr. Atkinson also describes a new genus and species of Coccidæ (*Pseudopulvinaria sikkimensis*), found on the under surface of the leaves of oaks, chestnuts, and cinchona: hitherto this has not appeared in sufficient numbers to effect much damage.

Mr. De Nicéville contributes an account of two injurious butterflies: one, which he identifies as *Suastus gremius*, devours the young and tender rice-shoots in the paddy-fields, but fortunately avoids the more mature plants. As a preventive for this pest, Mr. De Nicéville recommends raising the earthen walls round each plantation, so as to completely submerge the rice; this would prove fatal to all stages in the life-history of the butterfly, with the doubtful exception of the egg. The other report deals with *Lampides elpis*, whose larva devours the buds and young fruit of the Cardamom. Many allied forms have a gland on the eleventh segment, secreting a sweet fluid, much sought after by ants, but this seems to be absent in the species here described.

The remainder of the number is made up of thirteen reports and numerous short notes contributed by Mr. Cotes. Two of these reports are extensions of his "Notes on Economic Entomology," mentioned above. No mention is made of the Strawsonizer, whose value as a disseminator of insecticides has recently been recognized in England. The remaining eleven deal with caterpillars which attack the tea plant, sâl trees, rice, *Cedrela toona*, sugar-cane, sorghum, and the blankets belonging to the Army Clothing Department, and with various species of beetle injurious to the rice, bamboo, mango, and shorea tree. The beetle, which lives under the bark of the last-mentioned tree, closely resembles the *Tomicus chalcographus*, which is so injurious to the spruce in Europe.

The notes which conclude the work are often very fragmentary, but are full of suggestion, and there is no room to doubt that the lacunæ in the life-history of the insects with which they deal will soon be filled up, now that the authorities of the Indian Museum have provided a journal which will prove a means of intercommunication between the numerous entomologists and cultivators scattered over India.

The number is illustrated by four good plates of photo-etchings executed in Calcutta.

A. E. S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An elector (who must be a Head of a College) to the Sadlerian Professorship of Mathematics will be elected by the resident members of the Senate on June 3, from 1 to 2 p.m. The vacancy is caused by the death of Dr. Phelps, Master of Sidney Sussex College.

A. R. Forsyth, F.R.S., the author of the well-known "Treatise on Differential Equations," has been approved for the degree of Doctor in Science.

Dr. Hill, Master of Downing College, announces a class in Practical Histology, to be held during the Long Vacation.

The General Board of Studies recommend that the stipends of the following teachers of science be increased:—Mr. Gadow, King's College, Lecturer in Advanced Morphology, from £100 to £150; Mr. Marr, St. John's College, Lecturer in Geology, from £100 to £150; Mr. Harker, St. John's College, Demonstrator in Geology and Lecturer in Petrology, from £100 to £150; Mr. Barber, Christ's College, Demonstrator in Botany, from £100 to £150; an additional Demonstrator in Chemistry at a stipend of £100.

A conference on the local lectures under the University

Extension Scheme is to be held in Cambridge on July 9 and 10. Courses of lectures and practical work are to be arranged for students for local centres who are to reside in Cambridge during the month of August.

A very interesting report on the progress of the Extension movement by Dr. R. D. Roberts appears in the *Cambridge University Reporter* of May 27. The account he gives of the enthusiasm and energy displayed by certain of the Students' Associations attending Extension lectures is most encouraging, and shows how wide-spread is the influence for good exerted by the University in this connection.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for April 1890 contains papers on *Phymosoma varians*, Selenka, by Arthur E. Shipley (plates i. to iv.). The material for this paper was collected by Mr. Weldon in the Bahama Islands, where the species was fairly abundant in the soft coral rock. The general morphology and minute structure of this animal are described in great detail, and accompanied by some excellent illustrations; the head of Phymosoma is surrounded by a stiffened vascular horseshoe-shaped lip, the dorsal ends of which are continuous with the ends of a hippocrepian lophophor, which bears a crown of about eighteen tentacles—the number being always even; between this lophophor and the vascular lip is the crescentiform opening of the mouth. The author would keep the genus Phoronis as a form closely allied to the more normal *Gephyrea inermia*, and compares the head of Phymosoma as seen from above with a view of Phoronis.—On the spinning apparatus of the geometric spiders, by C. Warburton (plate v.). Proves by a series of interesting experiments that a spider's line does not consist of many strands fused or woven together, but ordinarily of two or four distinct threads; the ground line of the spiral is double only, and the two strands are bound together merely by the viscid matter, which envelops them.—On the structure and functions of the cerata or dorsal papillæ in some Nudibranchiate Mollusca, by Prof. W. A. Herdman (plates vi. to x.). In some six genera of British Nudibranchs examined, Herdman found that the dorsal papillæ, "cerata" of Lankester, were of two kinds—(1) those containing diverticula of the liver, as in the cases of Eolis and Doto, (2) those which were essentially but processes of the body-wall having no connection with the liver, as in Tritonia, Ancula, and Dendronotus. In Doris there are true branchiæ and no cerata. In Ancula both branchiæ and cerata are present. In Tritonia and Dendronotus there are cerata but no true branchiæ. In Doto and Eolis there are no true branchiæ. Morphologically all the forms of cerata are probably epipodial processes; they are not of primary importance either in respiration or in digestion, but give to the animals, by their varied shape and colours, appearances which are in some cases protective and mimetic, and in others conspicuous and warning, as may be best suited to the individual surroundings and mode of life.—Further observations on the histology of striped muscle, by C. F. Marshall (plate xi.).—On Chætobranchus, a new genus of Oligochætous Chætopoda, by Dr. A. G. Bourne (plate xii.). This remarkable worm was found in the mud from a "tank" in Madras town; it is furnished with a remarkable series of branchial processes, dorso-laterally placed—a pair to each of the anterior segments, commencing with the second segment; these processes completely surround a portion of the dorsal setæ bundles. The species has been named *Chætobranchus semperi*.—On the presence of Ranvier's constrictions in the spinal cord of Vertebrates, by Dr. W. T. Porter, of St. Louis (plate xii. *bis*).—A note to the editor from Prof. Bütschli, of Heidelberg, giving an account of his experimental imitation of protoplasmic movements. These protoplasma-like streaming properties of minute globules of a specially treated olive oil are of extreme interest.

American Journal of Science, May 1890.—Experiments with a pendulum-electrometer, illustrating measurements of statical electricity in absolute units, by Alfred M. Mayer. The apparatus described affords an inexpensive and ready means of presenting clearly to a class the nature of measurements of statical electricity in absolute units; the instrument may be made to measure to the $\frac{1}{10}$ of a dyne, and a series of experiments are given to show that it gives the law of inverse squares, serves to determine the law of dissipation of an electric charge, and that it allows measures to be made of electrical distribution on conductors and the determination of quantity and potential.—On electric potential as measured by work, by the same author. A graphical illustration is given of the fact that in the case of two electrified spheres the potential function is a measure of work.—An elementary proof of the earth's rigidity, by Geo. F. Becker. It is proved that a simple strain spheroid affords an approximation to the deformation of an elastic globe sufficiently close to serve as a basis for Sir William Thomson's demonstration of the rigidity of the earth; the whole subject also being presented in a clear and elementary manner.—On the hornblende of St. Lawrence County, N.Y., and its gliding planes, by George H. Williams. From the evidence brought forward it is concluded that an alteration of the symbols for the terminal planes of hornblende is necessary to show its analogy to pyroxene; and that this change must be made in accordance with the assumption that the gliding plane, now called the orthodome $P\bar{\infty}$ (101) is the basal pinacoid OP (001) as suggested by Tschermak in 1884.—Note on some secondary minerals of the amphibole and pyroxene groups, by Whitman Cross. In the course of the microscopical examination of some rocks from Custer County, Colorado, the author has observed two peculiar minerals of secondary origin, one an amphibole, and the other a pyroxene, and now describes their unusual properties, relationships, and mode of formation.—On spangolite, a new copper mineral, by S. L. Penfield. The specimen examined consisted of a rounded mass of impure cuprite mostly covered with hexagonal crystals of the new mineral. A full description of the habit, optical and physical properties, and chemical composition of the crystals is given.—Archæan axes of Eastern North America, by James D. Dana. The partly or wholly Archæan ranges in New England and Canada parallel and to the east of the Appalachian *protaxis* are described, and the geological importance of the included troughs or basins pointed out.—On the metamorphic strata of South-Eastern New York by Frederick J. H. Merrill.—The radiant energy of a standard candle; mass of meteors, by C. C. Hutchins. The whole radiant energy of the candle used was found to be $1{\cdot}23 \times 10^8$ ergs per second, and the radiant energy of the visible part $2{\cdot}46 \times 10^6$ ergs per second. The author also points out how such measures may be used to determine the mass of meteors.—Meteoric iron from North Carolina, by L. G. Eakins.—Distinctive characters of the order Hallopoda, by O. C. Marsh.—Additional characters of the Ceratopsidæ, with notice of new Cretaceous Dinosaurs, by the same author.

Botanische Jahrbücher, von A. Engler, vol. xi., contains the following papers:—An essay on the biological relations of the flower of *Aconitum*, by Dr. M. Kronfeld. He states that *Aconitum* is an excellent example of a flower adapted to a certain insect, and that it is dependent upon *Bombus* for its fertilization, a fact which is further borne out by a comparison of the geographical area of the two, that of *Aconitum* being entirely covered by the area of distribution of *Bombus*.—Dr. O. Drude, on the principles of distinction of the formations of vegetation (*Vegetationsformationen*) as illustrated by the flora of Central Europe.—A description, by L. Wittmack, of the plants belonging to the *Bromeliaceæ*, collected by Herr F. C. Lehmann in Guatemala, Costarica, Columbia, and Ecuador.—A description of new species of Nyctaginaceæ, by Dr. A. Heimerl, with one plate.—A monographic sketch of the genus *Helleborus*, by Dr. V. Schiffner.—A contribution to the knowledge of the distribution of the Scotch fir in Northern Germany, in which it is stated that on the mainland it extends north of the Elbe as a native plant, only as far as a line connecting Rostock, Schwaan, Güstrow, Wittenburg, and Geesthacht; in North-West Germany it is native only in the Upper Harz.—An anatomical investigation of the foliage leaves of the Arbutoideæ and Vaccinoideæ in relation to their systematic grouping, and geographical distribution leads Dr. Franz Niedenzu to the following conclusions: that the Arbuteæ are the oldest type, and of them more especially *Arbutus* and *Arctous*, while *Arctostaphylos* is more recent; the most recent group is the *Thibaudieæ*. These results are based upon details of the glandular and other hairs, of the teeth of the leaf, the epidermis and cuticle (130 pp. and 4 plates).—On the influence of the mean direction of the wind on the vegetation in the water, with references also to other phenomena of vegetation which depend upon the direction of the wind in the Western Baltic, by M. J. Klinge.—On a new *Potentilla* from Central America, by Dr. K. Fritsch.—Contributions to the knowledge of the Amaryllidaceæ, by Dr. F. Pax.—A list of the wild plants of the province of Wologda, by N. A. Ivanitzky.—On the

anatomical characters of the Hamamelidaceæ, examined with the object of using them as a basis for the systematic arrangement of the family, by A. Reinsch (1 plate).—A list of the Polypodiaceæ, Gramineæ, Cyperaceæ, and Juncaceæ, collected by Dr. Marloth in South Africa.—On *Cassine domingensis* Spr., by A. Garcke.—A treatise on the genus Platanus, with two plates, by J. Jankó. This paper has special reference to the detail characters of the leaf.—On two *Soldanellas* new to the flora of Hungary, by V. A. Richter.—At the end of the volume are abstracts of many recent memoirs published elsewhere, and a classified list of the most important works on systematic, geographical, and descriptive botany published in the year 1889.

Bulletin de la Société des Naturalistes de Moscou, 1889, No. 2.—On the origin of periodical comets, by Th. Bredichin (in French). The author examines into the cases of division of comets into two or more individuals, endeavouring to classify the better known ones into "families," and gives the formulæ for the cases when the impetus given to the corpuscles of a comet acted under a given angle to the plane of its motion.—Note on the genus *Bombus*, by General Radoszkowski (in French).—The Amphibian fauna of Europe: the *Anura*, by Dr. J. Bedriaga, being a full description (in German) of the two genera *Rana* and *Bufo*, their species, varieties, life, and geographical distribution.

No. 3.—On the modes of propagation of fresh-water fishes, by S. Nikitin (in French). M. Nikitin objects to the too hasty generalizations sometimes arrived at by men of science (especially with regard to Central Asia) as to the former communication between distant fluviatile basins and lakes which now have some species of fishes in common. He points out the possibility of the transport of the eggs of certain fishes by birds, and mentions the fact of young pikes, from six to ten centimetres long, being found in small temporary ponds on the banks of the Moskva river, where they could by no means have migrated themselves. Further inquiry is asked for.—The transport of electrical energy, by J. Weinberg (in German).—On the nesting of *Podoces Panderi*, by N. Zarudny.—The Amphibian fauna of Europe: the *Anura* (continued), by Dr. J. Bedriaga. The genera *Hyla*, *Pelobatus*, *Pelodytes*, *Discoglossus*, *Bombinatur*, and *Alytes*, are considered, and the author describes two new varieties of *Hyla arborea* under the names of var. *orientalis* and var. *Molleri*.—On the influence of weather upon plants and animals, by Alex. Becker (in German).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 8.—"Experiments on Vapour-Density." By E. P. Perman, B.Sc. Communicated by Prof. Ramsay, F.R.S.

Vapour-density of Bromine.—This work was undertaken in order to see if the results of Prof. J. J. Thomson's experiments could be verified; these appeared to show that bromine vapour dissociated on continued heating at a low pressure, and a comparatively low temperature. The method used was a modification of the Dumas method, by which a series of vapour-density determinations were made at different pressures, with the same identical material. The chief conclusions arrived at are (1) that no dissociation takes place at temperatures as high as 280°, and pressures as low as 20 mm., even on continued heating; (2) that bromine vapour has no tendency to form molecules with more than two atoms, on approaching the liquid state.

Vapour-density of Iodine.—The density of saturated iodine vapour was determined by an adaptation of Kundt's method of determining the velocity of sound in gases. The mean result was 126·9, showing that liquid iodine has the formula I_2.

Induction Spark through Iodine Vapour.—The same apparatus was used as in finding the vapour-density of iodine. No alteration of the wave-length in the iodine vapour (as indicated by the heaps of finely-divided silica on the lower part of the tube) occurred on passing a series of sparks, and then causing the glass piston to vibrate. Sparking does not appear, therefore, to produce permanent dissociation of iodine vapour, notwithstanding the results pointing to a contrary conclusion, obtained by Prof. Thomson. Neither bromine nor iodine vapour, when saturated, threw the silica into heaps; it appears that sound-waves cannot be propagated in a saturated vapour, for condensation will be produced either by the waves of compression or those of expansion (according to the nature of the vapour, and its temperature) and the rates of propagation of the two sets of waves will therefore be different.

Vapour-densities of Sulphuric Anhydride, and Aqueous Hydrochloric Acid.—These were determined by the same method as the vapour-density of bromine. The vapour-density of sulphuric anhydride indicated a formula SO_3, and that of aqueous hydrochloric acid showed that it is a mixture of molecules HCl and H_2O, and not a compound. In all these experiments the quantity of substance in the globe was not found by weighing, but by estimating it volumetrically, portions being drawn off and absorbed in a suitable liquid. The globe was heated by means of a vapour-jacket; the vapours used were those of alcohol, chlorobenzene, bromobenzene, and bromonaphthalene.

The author is greatly indebted to Prof. Ramsay for constant advice and assistance in carrying out the work.

May 22.—"The Chemical Products of the Growth of *Bacillus anthracis* and their Physiological Action." By Sidney Martin, M.D., Pathologist to the Middlesex Hospital. Communicated by Dr. Klein, F.R.S.

The bacilli were grown in a solution of pure alkali-albumin (made from serum-proteids) and of mineral salts of the composition of the salts of the serum.

The cultivation of the bacilli was continued for ten to fifteen days, and the organisms removed by filtering through Chamberlain's filter. The filtrate contained the products of the bacterial growth, viz.:—

(1) *Proto-albumose* and *deutero-albumose*, and a *trace of peptone:* all with the same chemical reactions as the similar bodies formed in peptic digestion.

(2) *An alkaloid.*

(3) Small quantities of *leucin* and *tyrosin.*

The chief characteristic of the anthrax proto- and deutero-albumose is their strong alkalinity in solution—an alkalinity not removed by absolute alcohol, by benzene, chloroform, or ether, or by prolonged dialysis. Acid-alcohol dissolves from the alkaline albumoses a trace of a poisonous body, but this is not in proportion to the toxicity of the albumoses. The albumoses are precipitated in an alkaline condition by saturation with NaCl (proto-albumose) or $(NH_4)_2SO_4$. The alkaloid is soluble in absolute alcohol, amyl alcohol, and in water; insoluble in benzene, chloroform, and ether. It is strongly alkaline in solution, and a powerful base, readily forming salts with acids. The sulphate crystallizes in small needles or prisms; the oxalate in long, branching needles or flat plates. From the salts the alkaloid is easily regained. In solution, the alkaloid is precipitated by phosphotungstic, phosphomolybdic, and phosphoantimonic acids and platinic chloride, but not by potassio-mercuric iodide. It is slightly volatile, and, when kept exposed to the air, it becomes acid, and loses, to a great extent, its poisonous properties.

Physiological Action.

(1) The mixture of anthrax proto- and deutero-albumose is poisonous. In small doses it produces in mice a local subcutaneous œdema, with some sluggishness, ending in recovery. Larger doses produce a greater œdema with more signs of illness, sluggishness leading to prolonged stupor, coma, and death in twenty-four hours or longer. A fatal dose for a mouse of 22 grams weight is 0·3 gram (subcutaneously injected). In some cases the spleen is enlarged: no organisms being present, as shown by gelatine tube cultivations. Boiling for a short time diminishes the toxicity of the proteid, but does not completely destroy it, and death may result from the boiled albumoses.

(2) The *anthrax alkaloid* produces symptoms and lesions similar to the albumoses, but much more rapidly and severely. The animal becomes ill directly after the injection, gradually becomes more and more sluggish, and dies in coma, or, if a non-lethal dose be given, it recovers from the state of stupor gradually. After death, enormous local subcutaneous œdema is found, with congestion and sometimes thrombosis of the small veins. Peritoneal effusion is occasionally present, and the spleen is usually enlarged, dark, and congested, or simply congested without being greatly enlarged. The fatal dose for a mouse weighing 22 grams is between 0·1 and 0·15 gram, death occurring in two to three hours.

The anthrax bacillus in digesting the alkali-albumin forms (1) proto-albumose, (2) deutero-albumose, (3) an alkaloid. The alkalinity of the albumoses may explain their toxic properties, being due to the fact that the alkaloid is in a "nascent" condition in the albumose molecule. The bacillus forms the alkaloid

from the albumose, and it is possible that the living tissues have a similar action when the albumose is introduced into a living animal.

Entomological Society, May 7.—Captain Henry J. Elwes, Vice-President, in the chair.—Mr. H. Goss, the Secretary, read a letter from the Vicar of Arundel, asking for advice as to the course to be taken to get rid of the larvæ of a beetle which were destroying the beams of the parish church. Mr. C. O. Waterhouse said he had already been consulted on the question, and had advised that the beams should be soaked with paraffin oil.—Dr. Sharp exhibited specimens of *Caryoborus lacerdæ*, a species of *Bruchidæ*, and the nuts from which they had been reared. He stated that these nuts had been sent him from Bahia by the late Señor Lacerda, about six years ago, and that one of the beetles had recently emerged, after the nuts had been in this country for five years. Dr. Sharp also exhibited several specimens of Diptera collected by Mr. Herbert Smith in St. Vincent, and read a letter from him to Mr. Godman on the subject of the vast number of species of this order which he had recently collected in that island. Mr. McLachlan, F.R.S., Dr. Mason, Mr. Waterhouse, and Captain Elwes took part in the discussion which ensued.—Mr. R. F. Lewis, on behalf of Mr. W. M. Maskell, of Wellington, New Zealand, exhibited and read notes on about twenty-five species of *Coccidæ* from that colony. He also exhibited some specimens of the larvæ and imagos of *Icerya Purchasi*, Maskell, obtained from Natal, where the species had proved very destructive to orange, lemon, and other fruit-trees. He also showed specimens of the larvæ of an allied species from Natal, originally assigned by Mr. Douglas to the genus *Ortonia*, but which Mr. Maskell was inclined to regard as a new species of *Icerya*. Mr. McLachlan and the Chairman commented on the interesting nature of the exhibition, and the importance of a knowledge of the parasites of injurious insects, in connection with which special mention was made of the researches and discoveries of Prof. Riley.—The Secretary exhibited, on behalf of Mr. T. D. A. Cockerell, of Colorado, a large collection of insect-galls, and read a letter from Mr. Cockerell on the subject. Dr. Mason said he should be happy to take charge of these galls, with a view of rearing the insects and reporting the results.—Mr. W. H. Bates, F.R.S., communicated a paper entitled, "On New Species of *Cicindelidæ*."

Royal Meteorological Society, May 21.—Mr. Baldwin Latham, President, in the chair.—The following papers were read:—Rainfall of the globe, by Mr. W. B. Tripp. This was a comparative chronological account of some of the principal rainfall records. The earliest record is that of Paris, which commenced in 1689. The English records began in 1726. The rainfall observations in the southern hemisphere do not extend over a very long period; at Adelaide they were commenced in 1839, but they do not go back further than 1866 for New Zealand. The greatest fall in any particular year at the stations given by the author was 160·9 inches at St. Bernard in 1839, and the least 3 inches at Sandiego in California in 1863. By combining the stations in the northern and southern hemispheres the author finds that in recent times the years with the highest average rainfall were 1878, 1879, and 1883, and the years with the lowest average were 1854 and 1861.—Mutual influence of two pressure plates upon each other, and comparison of the pressures upon small and large plates, by Mr. W. H. Dines.—On the variations of pressure caused by the wind blowing across the mouth of a tube, by Mr. W. H. Dines. In these two papers the author gives the results of some experiments on wind pressure which he has made mostly on a whirling machine at Hersham, Surrey. From these experiments it seems probable that a decrease of pressure per square foot with an increase of size of plate may be taken as a general rule.

Geological Society, May 14.—Dr. A. Geikie, F.R.S., President, in the chair.—The following communications were read:—The so-called Upper Lias Clay of Down Cliffs, by S. S. Buckman. The blue clay of Down Cliff, Dorset, which has been referred to the Upper Lias, has yielded Ammonites of the genus *Dumortieria* to the author, notably *D. radians*. This blue clay is *below* the Yeovil Sands; but the position of *D. radians* in the Cotteswolds is in the limestone *above* the Cotteswold Sands, which has been placed in the Inferior Oolite series. The author, by combining the Down Cliffs and Chideock Hill sections, obtains a sequence of beds from the Middle Lias to the top beds of the Inferior Oolite, including the zones of *spinatum*, *commune*, and *falciferum*, *jurense*, *opalinum*, *Murchisonæ*, *concavum*, and *Parkinsoni*. The genus *Dumortieria* binds the *opalinum* and *jurense* zones together; while at Symondsbury Hill the author has found *Ludwigia Murchisonæ* and *Lioceras opalinum* in the same bed, which renders it difficult to draw a line of demarcation between Lias and Oolite at the top of the *opalinum* zone. The facts adduced in the paper furnish additional evidence of the untrustworthiness of a grouping which depends upon lithological appearances, and it was because no satisfactory line could be drawn between Lias and Oolite that the author, in a previous paper, supported the continental plan of grouping Upper Lias and part of the Inferior Oolite under the term Toarcian upon palæontological grounds. In the present paper he furnishes further statements in support of this view. After the reading of this paper some remarks were offered by Mr. H. B. Woodward, Mr. Hudleston, and the President.—On some new mammals from the Red and Norwich Crags, by E. T. Newton.—On burrows and tracks of Invertebrate animals in Palæozoic Rocks, and other markings, by Sir J. William Dawson, F.R.S.—Contact-alteration at New Galloway, by Miss M. I. Gardiner. Communicated by J. J. H. Teal.

Zoological Society, May 20.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Gambier Bolton exhibited a series of photographs, principally of animals living at the Society's Gardens and in Mr. Walter Rothschild's menagerie.—Prof. Flower exhibited a photograph of a nest of a Hornbill (*Toccus melanoleucos*), taken from a specimen in the Albany Museum, Grahamstown, in which the female was shown "walled in."—A communication was read from Sir Edward Newton relating to the reported discovery of Dodo's bones in Mauritius in 1885, by the late Mr. Caldwell. It appeared that there had been some error in the matter, and that the bones discovered were not those of the Dodo.—Mr. Sclater, F.R.S., pointed out the characters of a new Toucan of the genus *Pteroglossus* from the Amazons, proposed to be called *P. didymus*.—Mr. R. Lydekker read a paper describing some bird-remains from the cavern-deposits of Malta. These remains indicated a Vulture larger than any existing species, which, from the characters of the cervical vertebræ, he referred to the genus *Gyps*, under the name of *G. melitensis*. They also comprised some bones of a crane, of the size of *Grus antigone*, for which the name *Grus melitensis* was proposed.—Dr. Hans Gadow gave an account of some cases of the modification of certain organs in Mammals and Birds which seemed to be illustrations of the inheritance of acquired characters.

EDINBURGH.

Royal Society, May 19.—After the reading of some obituary notices, Prof. Crum Brown read a paper written by himself and Dr. J. Walker on the synthesis of sebacic acid.—Prof. Tait communicated a note on some remarkable quaternion formulæ.—Dr. Alexander Bruce read a paper on the roots of the auditory nerve and their connections.

PARIS.

Academy of Sciences, May 19.—M. Hermite in the chair.—Experiments on the deformations experienced by a spheroidal envelope subjected to pressure; possible applications to the terrestrial globe, by M. Daubrée. From the experiments described in this and in a previous communication, it appears that the author has been able to produce in various spheroids configurations like those exhibited by the earth's crust. He finds that the southern parts of the three continental masses are not deviated towards the east because of the influence of the earth's rotation, but by the effect of simple torsion in a spheroidal heterogeneous envelope subjected to contraction, similar reasoning is extended to explain characteristic canals of Mars.—New method of calculation for the interpolation and correction of meteorological observations, by M. Marc Dechevrens. The interpolation formula generally used in researches into the laws of variations of meteorological phenomena, and due either to Bessel or Fourier, is long and tedious. From considerable use of this method the author has found that it may be simplified, and in the memoir presented shows how arithmetic—multiplication and addition—may replace trigonometry, angles and logarithms.—Observations of Brooks's comet (*a* 1890) made with the great equatorial of Bordeaux, by MM. Rayet and Courty. Measures of position are given. A photograph of the comet was obtained on May 15 with an exposure of one hour. It appears on the negative as a disk having a sensible diameter,

surrounded by nebulosity, and connected with a head about 2′ long.—On the asymptotic value of the polynomials of Legendre, by M. Stieltjes.—On the determination of a point, by M. Hatt.—On the isomeric states of chromic bromide, by M. A. Recoura. The author shows that, just as in the case of the chloride, two sesquibromides may be prepared which on treatment with alkaline hydrates both yield the chromic hydrate belonging to the series of violet chromic salts. He gives a method for the preparation of the green salt in crystals of the composition Cr_2Br_6, $12H_2O$; these crystals are stable when solid, but the salt changes into the violet modification rapidly when in solution. The heat of combination of the green salt (in solution) with NaOH is given as 33·1 cal., whereas that of the violet salt is but 21·6 cal.; during the transformation from the green to the violet modification 11·5 cal. are disengaged.—On the existence of a crystallized hydrated ferric oxychloride, and its transformation into a dimorphous variety of göthite, by M. G. Rousseau. By prolonged heating of a concentrated solution of ferric chloride, in the presence of a little calcium or magnesium carbonate, in a sealed tube, crystals are obtained of the formula Fe_2Cl_6, $2Fe_2O_3$, $3H_2O$. In boiling water a reaction occurs which may be expressed thus—

$$Fe_2Cl_6,\ 2Fe_2O_3,\ 3H_2O + nH_2O = 3(Fe_2O_3,\ H_2O) + 6HCl + (n-3)H_2O;$$

the body Fe_2O_3, H_2O possessing the composition of göthite and only differing from the latter in some of its physical properties.—On some new double chromates, by MM. M. Lachaud and C. Lepierre. Double chromates of lead with potassium, lithium, and sodium are described, similar products being obtained in the case of each of the alkaline metals. Yellow bodies of the composition $PbCrO_4$, M_2CrO_4, and orange compounds of the formula $PbCrO_4$, M_2CrO_4, $2PbO$, have been prepared.—On the crystallization of alumina and some other oxides in hydrochloric acid gas, by MM. P. Hautefeuille and A. Perrey.—Note on the *bouquet* of wines and brandies, by M. A. Rommier. It is shown that different ferments produce from the same grapes wine of different flavour, and that solutions of sugar fermented by means of the natural ferments obtained from different districts yield on distillation alcohols possessing different odours; and it is suggested that the characteristic bouquet is due to a compound ether formed from the alcohol combined with a fatty acid produced from the fat which each ferment manufactures from the sugar for its own use.—On the clinical characters of true intermittent fevers; the law and preventive treatment of relapses, by M. Alcide Treille. The author gives his method of treatment by sulphate of quinine, which he has used in fever cases in Algiers for about twenty years.

BERLIN.

Physiological Society, May 9.—Prof. du Bois Reymond, President, in the chair.—Dr. Löhers spoke on the effect of inhalations of bromethyl and nitrous oxide on the circulation and respiration, deduced from experiments made with a view to obtaining a physiological basis for the use of these anæsthetics. Bromethyl slows the respiration, leaving the inspirations unaltered, but rendering the expirations weaker and weaker, until they disappear entirely; at an early stage of its action respiration becomes again normal if the animal is supplied with fresh air, but later on this is not the case, and death ensues by the action of the drug on the heart. The effect on the circulation is to quicken it at once; the blood-pressure falls, the pulse becomes arhythmic, and finally ceases; the left side of the heart is now found to be empty, the right gorged with blood; it appears that bromethyl affects the two halves of the heart differently, and thus probably gives rise to the asymmetry of the pulse. When the vagi are cut the effect of the drug on both circulation and respiration is longer in making its appearance. Nitrous oxide has a more powerful action on respiration, the inspirations diminishing rapidly and ceasing suddenly. Normal respiration may be restored by fresh air if the action of the drug has not been too prolonged. The effect on the heart is to increase the blood-pressure. It appears on the whole that bromethyl must be more cautiously employed than nitrous oxide as a narcotic.—Dr. Blaschko made a further communication on the architecture of the skin.—Dr. Löwy gave an account of experiments upon the irritability of the respiratory centre. The experiments were conducted on human beings in such a way as to discriminate between the effects of varying irritability of the centre and varying strength of stimulus applied to it in determining variations in the magnitude of the respiratory movements. The stimulus used was carbonic acid gas mixed in definite proportions with the inspired air. It appeared that dyspnœa did not supervene with less than 6 per cent. of CO_2 in the air; and that in the various states of sleep, whether natural or resulting from narcotics, and after the administering of alcohol and camphor, equal increments of CO_2 lead in all cases to an equal increase of the respiratory movements; hence in all these conditions the irritability of the centre must have been the same. Morphia, on the other hand, lessens the irritability.—Prof. Gad stated that he had some years ago observed a capillary network among the cells of the epithelium which covers the floor of the fourth ventricle, and that Retzius had observed a similar case in the internal ear. It now appears that the occurrence of blood-vessels between the cells of an epithelium is extremely rare, and he therefore urged morphologists to keep a look-out for and to investigate any cases which they may observe.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Treatise on Diseases of the Nose: Dr. G. Macdonald (A. P. Watt).—The Canary Book, Part 1: R. L. Wallace (Gill).—British Cage Birds, Part 1: R. L. Wallace (Gill).—Plant Organization, 2nd edition: Dr. R. H. Ward (Arnold).—Fifth and Sixth Annual Reports of the Bureau of Ethnology: J. W. Powell (Washington).—British Birds, Key to the present Classification: W. H. Wintringham (Grimsby News Company).—Traité Encyclopédique de Photographie, doux. fasc. (Paris, Gauthier-Villars).—Science Applied to Work: J. A. Bower (Cassell).—The Golden Bough: J. G. Frazer (Macmillan).—The Advancement of Science: E. Ray Lankester (Macmillan).—Mungo Park and the Niger: J. Thomson (Philip).—Epitomes of Three Sciences:—Comparative Philology, Psychology, and Old Testament History: H. Oldenberg, J. Jastrow, and C. H. Cornill (Chicago, Open Court Publishing Company).—The Birds of Essex: M. Christy (Simpkin).—Meteorology of Sheffield, 1887–89: E. Howarth.—Earthworks of Ohio: C. Thomas (Washington).—Textile Fabrics of Ancient Peru: W. H. Holmes (Washington).—The Problem of the Ohio Mounds: C. Thomas (Washington).—A Summer School of Science: Prof. P. Geddes (Edinburgh, Thin).—The Pterylography of Birds' Wings: W. P. Pycraft (Leicester).

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