THURSDAY, APRIL 23, 1896.

A NEW BOOK ON MAN.

Ethnology. By A. H. Keane. "Cambridge Geographical Series." Pp. xxx + 442. (Cambridge: University Press, 1896.)

A HANDY but comprehensive work on ethnology has long been required alike by the student and general reader, and it is with pleasure and interest that we welcome the appearance of a book which is claimed by the author to be a synthesis and a trustworthy guide.

Mr. Keane's book is divided into two parts: (1) Fundamental Ethnical Problems; and (2) The Primary Ethnical Groups. After a definition of terms, which is rather unsatisfactory, as is also the title of the book itself, the author deals with the physical evolution of man, and here as elsewhere the evolution doctrine is accepted. In this chapter, there is the inevitable phylogenetic tree; but in this instance it is furnished with a bunch of unexplained roots. Whatever truth this scheme may illustrate, we fail to see the conclusion that "from this diagram it is made evident that the ascent of the Hominidæ is in an independent line from some long extinct generalised form," &c. When will people learn that a phylogenetic tree does not *prove* anything! The treatment of the mental evolution of man in a short chapter is somewhat inadequate for that most important subject. The antiquity of man is dealt with in various chapters; in the prefatory general considerations, "Croll's last two glacial epochs" are "accepted in all their fulness," and the author decides in favour of interglacial man, who "specialised not less, probably much more, than half-a-million years ago." The chapters on Palæolithic and Neolithic man are useful summaries, but with several questionable statements. Geographers will scarcely admit that "the explanation," of the attractiveness of Denmark to Neolithic men, "lies in the physical and biological conditions of a region washed by the warm waters of the Gulf Stream." The argument for the specific unity of man will prove of service to many readers. It is strange that, though the meaning of the terms genus, species, and variety "is clearly defined in a way that gives rise to no misunderstandings," Mr. Keane attributes to Linnæus the erection of "four species" of the group *Homo sapiens* (p. 164), whereas these were evidently regarded as varieties of that species by the great Swedish naturalist. On p. 25 we find a paragraph commencing thus: "HOMINIDÆ. (Linné's Genus *Homo*), with no specific divisions, but four primary varieties"—a system of nomenclature that no biologist would recognise. Somehow or other, in spite of his statement that the meaning of the terms species, &c., is so fixed as to give rise to no misunderstanding, the author does not appreciate the rules for zoological nomenclature; apparently his view is that the single species of *Homo* differentiated in early times into four varieties, which he calls *Homo Æthiopicus*, *Homo Mongolicus*, *Homo Americanus*, and *Homo Caucasicus*, so that we now have four varieties in the genus, but no species.

In the chapter on the physical criteria of race, Mr. Keane gives an account of the data utilised in classifying the different groups of man, and a selection of the various systems of classification that have been adopted; the ingenious system of Deniker deserves a more detailed description than is accorded to it. The remarkable statement on p. 171, that the greater abundance of pigment in the skin of the negro "seems due to the stimulating action of the solar heat combined with moisture and an excess of vegetable food, yielding more carbon than can be completely assimilated, the character being then fixed by heredity," must not pass unchallenged. It is true that Waitz adduces many examples to show that "hot and damp countries favour the darkening of the skin," and though this may be a factor, there are too many exceptions for it to be a sufficient cause; evidently this has also struck the author, but the fixation of black carbon through an excess of vegetable food is a theory that is decidedly comical, though it is doubtless offered in good faith. Mr. Keane devotes nearly the whole of the section on the mental criteria of race to a disquisition on the evolution of language. He asserts that monosyllabism is not the first but the last stage in the growth of a language; if this be true, then the German language must be in its infancy. Several of his views on linguistic evolution are, to say the least of it, heterodox, and will probably lead to further discussion.

The second part, which deals with the main divisions of mankind, is a most useful summary of a vast range of reading, and will prove of great utility to all interested in the subject, although there are many statements which will not approve themselves to every specialist. Mr. Keane argues in favour of the evolution of the pliocene precursor of man in the Indo-African Continent, which has replaced Sclater's Lemuria. This continent extended from South India to Africa and Madagascar, including the intermediate islands, and also was in biological relation to the hypothetical Austral Continent, which extended from New Guinea and Tasmania to the islets of St. Paul and Amsterdam. "Thus when the pliocene precursor, wherever evolved, began to spread abroad, he was free to move in all directions over the eastern hemisphere."

One or two examples will illustrate Mr. Keane's views on certain problems. Besides the Negritoes who extended along Malaysia to New Guinea, there was a primitive population of Melanesian Papuans, who also spread over the whole of Oceania as far as Hawaii, Easter Island, and New Zealand. These were also the aborigines of Australia, who thence passed over into Tasmania; Australia also received a contingent of "Caucasian Melanochroi" (*i.e.* the Dravidian element in Australian ethnology), and also a Malay infusion, "while the Neanderthal characters persisting here and there would be traceable to the *Ur-Einwanderung* of the pliocene precursor from the Indo-Austral Continent."

"The Melanesian language [which Dr. Codrington has shown to be the most primitive existing form of the Malay-Polynesian group] is not indigenous in its present home, but must have been introduced and imposed upon the Papuan natives by some foreign people in remote prehistoric times. This people is none other than the Eastern Polynesians, a branch of the Caucasic division, who possibly in the Neolithic period migrated from the Asiatic mainland to Malaysia and thence eastwards to the remotest islands of the Pacific Ocean."

Mr. Keane, as we have seen, is not particularly happy when attempting to explain the effect of environment on man, as the following extract will also prove.

"It has been shown that the precursor was most probably furry, with a woolly under and a sleek outer coat, and it is conceivable that in a volcanic environment like that of Java, it might have been advantageous to shed the wool and retain the sleek hair, together with all the other physical characters of the primitive Negrito."

The white race (*Homo Caucasicus*, as Mr. Keane delights to term it) is held by the author to have evolved in, and dispersed from, North Africa; but he strangely omits to refer to Dr. D. G. Brinton, who, in his "Races and Peoples" (1890), had already promulgated that view.

It is evident that Mr. Keane is a very diligent and widely-read literary man, but he is decidedly weak on the scientific aspects of his subject. Lastly we must criticise those figures which were copied from the author's "Types of the Races of Mankind," in Longmans' New Atlas. The process-blocks from these lithographs have a very coarse appearance, and offer a marked contrast to those taken from photographs. On the whole, the selection of the illustrations of racial types is well made.

Although there is a good deal of what may be termed contentious matter, besides numerous errors, in Mr. Keane's book, we can recommend it as a most useful introduction to a very complicated study; and as the author has brought together and abstracted a large number of references, the student can use the book as a point of departure, and thus it will serve as a base for a more extended or detailed survey of this really important branch of science. A. C. HADDON.

RIGID DYNAMICS.

An Elementary Treatise on Rigid Dynamics. By W. J Loudon, B.A., Demonstrator in Physics in the University of Toronto. Demy 8vo, pp. ix + 236. (London: Macmillan and Co., 1896.)

THERE are few mathematicians who do not vividly recollect the difficulties they experienced when reading "Rigid Dynamics" for the first time. Mr. Loudon's treatise does much to smooth away these difficulties; and if it still leaves undone much that might have been done in simplifying the subject for beginners, it nevertheless fills a gap the existence of which has long been felt among teachers.

From a purely mathematical standpoint, we have none but praise to offer. As a digest of the earlier matter of Dr. Routh's treatise up to, but not including, Lagrange's generalised equations of motion, it will be welcomed by all students whose primary object is to master the equations of motion of a rigid body without diving too far into higher applications.

The order of treatment is essentially based on "Routh," with the exception that Mr. Loudon gives no separate chapters on "Motion in Two Dimensions," "Momentum," and "Vis Viva." Thus the first two chapters deal with "Moments of Inertia" and "Ellipsoids of Inertia," and are followed by chapters on "D'Alembert's Principle" and on "Motion about a Fixed Axis." After the latter problem has been considered both for finite and "impulsive" forces, the same is done for motion about a fixed point. In this connection, the equations of motion of a top, and of a body moving under no forces, are discussed as far as they can adequately be treated without using elliptic functions. The book concludes with a chapter on the "Gyroscope," in which the experimental proof of the earth's rotation is figured and described at some length.

One very commendable feature is the large number of diagrams. To represent on paper three planes at right angles in a rigid body is a task which previous writers have shirked; but Mr. Loudon's large and bold figures will do much to assist the reader in forming a concrete idea of the motions he is dealing with. We might instance more especially Fig. 50, illustrating the motion of a top spinning on a horizontal plane, and Fig. 58, illustrating how the motion of a rigid body under no forces is completely represented by the rolling of the momental ellipsoid on a fixed plane.

To our mind the book's chief drawback, considered as an *elementary* treatise, lies in the author having, no doubt unconsciously, followed Dr. Routh's analytical methods too closely instead of striking out in simpler lines of treatment. That it is a useful exercise to start every problem by writing down the fundamental equations

$$\Sigma m\frac{d^2x}{dt^2} = X, \quad \Sigma m\left(y\frac{d^2z}{dt^2} - z\frac{d^2y}{dt^2}\right) = L$$

cannot be doubted, but the ordinary beginner often finds it hard to proceed from these equations to the final solution. What he now chiefly requires is a thorough grasp of the nature and significance of "angular momentum." We by no means wish to overrate the educational value of the familiar type of Tripos rider, whose solution merely involves writing down the equations of conservation of angular momentum and energy, and eliminating between the two; at the same time, we do think that much may be learnt from problems of this class, especially by the beginner. For a similar reason we are sorry not to find "Motion in Two Dimensions" treated earlier. Again, in deducing Euler's equations of motion, it seems a pity that the author has adopted Dr. Routh's laborious proof, a proof which is always found very hard to grasp. Its difficulty is largely due to the necessity of proving the relation

$$\frac{d\omega_1}{dt} = \frac{d\omega_x}{dt}$$

connecting the rates of change of the angular velocities about fixed and moving axes respectively. The author gives two proofs of this identity, occupying four pages of difficult mathematics; but the result is, after all, only a particular case of the general property of moving axes, which, when applied to any *other* vector quantity (angular momentum, for example), assumes the far more intelligible and suggestive form

$$\frac{dh_x}{dt} = \frac{dh_1}{dt} - h_2\omega_3 + h_3\omega_2$$

and thus leads to a far shorter proof of Euler's equations.

In a few respects the book slightly lacks in finish. A tyro might easily complete the chapter on "D'Alembert's Principle" without having his attention drawn to what that principle really is, or might even mislead himself into the impression that the principle consisted in the mere equations

$$\Sigma(f_1) = \Sigma(f_2) = \Sigma(f_3) = 0.$$

Again, on p. 127, the author commences to explain the "sleeping" of a top, but stops short after briefly indicating that the effect is due to friction. It would require considerable mathematical ability to prove the phenomenon by actually integrating the equations of motion, taking account of friction in the manner suggested.

Most people find it easier and quite as effectual to explain the observed results from general principles.

Such difficulties would mostly disappear in the hands of an accomplished teacher. Moreover, the volume is exceedingly rich in examples, both illustrative and otherwise, and, in addition to those contained in the text, there is a collection of 300 problems at the end. As a class-book, or for use in the lecture-room, Mr. Loudon's treatise may therefore be safely recommended. G. H. B.

OUR BOOK SHELF.

Our Country's Butterflies and Moths, and how to know them. A Guide to the Lepidoptera of Great Britain. By W. J. Gordon, author of "Our Country's Birds," "Our Country's Flowers," &c. With a thousand examples in colour by H. Lynn, and many original diagrams. Crown 8vo, pp. vii + 150, plates 32. (London: Day and Son, 1896.)

ONE remarkable circumstance noticeable in the present plethora of works on British butterflies and moths, is that almost every new one is composed on a different plan. The present book reminds us a little of Wood's "Index Entomologicus," except that the figures are not reduced; and it will be very useful to schoolboys commencing a collection. All the *Macro-Lepidoptera* are figured, to the *Geometridæ* inclusive, and all the genera of *Micro-Lepidoptera*, except in the *Tineæ*, where the selection is limited to typical specimens of each family. The execution, though unequal, is fairly good on the whole, and most of the species figured will be easily recognised, though the want of figures of undersides, and of both sexes in the butterflies will be severely felt in many cases. One or two of the figures are, however, so unlike the insects they are supposed to represent, that our first impression on opening the book was that they were intended to represent some foreign species. We may specially instance the figure of *Sphinx pinastri* on plate 7, while that of *Smerinthus populi* is not much better. But this matters less in the case of conspicuous and easily identified species; and where accuracy is really needed, as in the smaller *Geometridæ*, the execution is much better. The letter-press largely consists of indices and tables, and contains much useful information relating to *Lepidoptera*, and even to insects in general. The main characteristics of the families, genera and species are briefly noticed, as well as their sizes and times of appearance, but nothing is said about localities or comparative rarity. Notices of the larvæ are limited to those of the butterflies; English as well as Latin names are used throughout. It is only fair to the author to say that we have rarely seen a book in which so much information was compressed into so small a space.

Handbook for the Bio-Chemical Laboratory. By Prof. John A. Mandel. Pp. 101. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1896.)

IN this handbook will be found detailed descriptions of the methods of preparation of the most important substances which enter into the composition of the fluids and tissues of the animal body, and a synopsis of the tests for such substances, arranged in alphabetical order. Students of physiological chemistry will find the volume a handy laboratory manual.

LETTERS TO THE EDITOR.

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

Buried Celluloid.

IT has occurred to many people, that perhaps celluloid migh be useful as an insulator for electric cables. I feared it migh deteriorate. I have made an experiment of 4½ years duration which may be of use in connection with the subject. On August 15, 1891, I took four photographic quarter-plate celluloid plates, with the gelatine removed, and treated them as follows:—

No. 1 was nailed to an outhouse, and became rotten in a year.
No. 2 was 1 foot deep in garden soil.
No. 3, 1 foot deep in gravel.
No. 4, 1 foot deep in a rubbish heap.

The last three were dug up on April 6, 1896. Nos. 2 and 4 were in as perfect condition as ever. No. 3 has some sand rubbed in, but is perfectly sound.

The experiment was made at Pitlochry, N.B. The specimens can be seen at my office. GEORGE FORBES.

34 Great George Street, Westminster, S.W., April 16.

Suggested Photography by Transmitted Heat Rays.

I AM no chemist, and may be mistaken, and what I propose would be more curious than useful; but I believe it would be possible to get a visible shadow of a small object which was concealed from sight by being enclosed within an opaque material. There are substances opaque to light, but which transmit the rays of heat; most readily, I suppose, those from the sun, and these are substances on which such heat rays impinging would cause some visible change.

If the heat-transmitting substance allows the rays to pass without dispersion, preserving their rectilinear direction, then these rays falling upon a duly prepared screen would cause a visible change upon a portion of its surface; and any ordinary opaque object placed within the heat-transmitting substance would cast a shadow, dark, or bright, as the case may be.

Penzance. REGINALD COURTENAY.

Influence of Terrestrial Disturbances on the Growth of Trees.

As the subject of forestry has recently been much under discussion, and appears to be exciting more interest in this country than it was, I trust I shall not be trespassing upon your space in calling attention to a peculiar case of timber growth which I have noticed, and in soliciting the opinions of those of your readers who are likely to be well-informed upon foreign woods, as to its true cause.

There is in the British Museum of Natural History the cross-section of a large Douglas fir grown in British Columbia, and stated to be more than 500 years old at the time it was felled, which was, I believe, in 1885. An attractive feature in the section is that the annual rings have been marked off chronologically, and some historical event, contemporaneous with the growth of the ring to which the date is attached, is given.

A glance, however, at one part of the surface of the wood, which is polished, reveals a very remarkable modification of the annual rings, which appears to have taken place towards the close of the first century of the tree's existence. About twenty of the rings are there crowded so closely together as to present, at a short distance, the appearance of a zone about three-quarters of an inch wide running round the trunk, and differently coloured from the rest of the wood. It is also to be particularly observed that the change to ordinary growth on either side of the zone is abrupt; and, further, that no such phenomenon is afterwards presented during the many centuries of the tree's subsequent development.

The suddenness of the changes puts out of court the idea that the check to growth might have been due to overcrowding in the forest during the period of the struggle for supremacy over its fellows, which the tree would undergo, because any effect from this cause would only come on gradually, and diminish in the same manner.

The supposition that twenty bad seasons occurred in succession, is unlikely under any climatic conditions with which we are familiar. It is true that two or three rings of growth in a tree are often very close together in consequence, perhaps, of adverse seasons, or insect depredations upon the leaves; and this is easy to understand.

It seems therefore not easy to say what can have occasioned this apparently abrupt cessation of vigour in a tree which had previously made good progress, and which again as suddenly renewed its former healthy condition.

Would any extraordinary convulsion of nature be likely to account for the facts of the case? But might we not expect to see evidence of similar catastrophes at various epochs in a tree of such great age? Nothing, however, afterwards appears but ordinary average growth, becoming gradually less with increasing age.

Now the dates given on the part of the section about where the thinning occurs run up comparatively close to, but do not quite correspond with a very remarkable period of the world's history, viz. towards the middle of the fourteenth century. If the tree had ceased to grow for a few years before it was cut, the correspondence would be very close indeed.

About this period many extraordinary particulars are given in Hecker's "Epidemics of the Middle Ages." In this work details occur of the appalling convulsions, terrestrial and atmospheric, to which the world was subjected for some years prior to the outbreak of the Black Death.

Amongst others of a similar tendency the following passages appear.

"Mighty revolutions in the organism of the earth of which we have credible information had preceded it (the Black Death). From China to the Atlantic the foundations of the earth were shaken; throughout Asia and Europe the atmosphere was in commotion, and endangered by its baneful influence both vegetable and animal life."

"Before the earthquake (that of Cyprus) a pestiferous wind spread so poisonous an odour that many were overpowered by it, and expired in dreadful agonies. This phenomenon is one of the rarest that has been observed, for nothing is more constant than the composition of the air."

"Earthquakes were more general than had been within the range of history. In thousands of places chasms were formed from whence arose noxious vapours."

"It is probable, therefore, that the atmosphere contained foreign and sensibly perceptible admixtures to a great extent, which at least in the lower regions could not be decomposed and rendered ineffective by separation."

"The order of the seasons seemed to be reversed—rains, floods, and failures in crops were so general that few places were exempt from them."

"In the inmost depths of the globe that impulse was given in the year 1333, which in uninterrupted succession for six-and-twenty years shook the surface of the earth even to the western shores of Europe. From the very beginning the air partook of the terrestrial concussion. Atmospherical waters overflowed the land, or its plants and animals perished under the scorching heat." (Hecker's "Epidemics of the Middle Ages," trans. Babington.)

Particular mention is made of the fearful natural calamities then visited upon China, which seems to have suffered more than any other place recorded. Now this points to the special activity of subterranean forces on the Pacific sea-board; and, consequently, British Columbia is not unlikely to have come in for a heavy share of the physical disturbances of that period. If so, is it not very probable that as strong an impression would be made upon the plants and animals of that part of the globe as upon those of other countries that are mentioned? Now trees are the only beings at present living which could possibly have been contemporary with these calamities; and, as it is not difficult to determine their age approximately, it would be very interesting to carry out investigations in other instances, and thus ascertain if nature has recorded in the giants of the forest some impress of events which were fraught with such dire consequences to the human race.

Henry J. Colbourn.

Woolhampton, Reading, April 4.

Carib Pottery.

Last year in St. Kitts, in a cliff fresh cut by a wash, a gentleman found what were apparently the contents of a Carib grave—fragments of pottery, two complete utensils, and pieces of human bones. The whole is now in the possession of Dr. W. J. Branch.

This is the first discovery, as far as I can ascertain, of either bones or pottery in the Leeward Islands, though Carib pottery is common in some of the Windward Islands. Since then, however, I have found a kitchen-midden, and procured plenty of small fragments, along with crab-claws, broken shells, fish-bones, &c.

The human bones above mentioned are the shafts, without the ends, of a femur, tibia, and fibula, a fifth metatarsal, a phalanx of the thumb, and several chips of the other fibula and

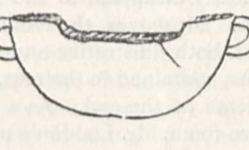

Fig. 1.

Fig. 2.

tibia. The tibia is curious as being very flat—almost two-sided, the interosseous border being merely a ridge on the outer surface.

The pottery consists of an oval bowl (Fig. 1), which the finder unhappily broke, a small plate (Fig. 2), and a number of fragments. The bowl is mended so as to be now entire; it measures $9\frac{1}{4}$ in. by 6 in. and $3\frac{3}{4}$ in. in depth; and was probably made in St. Kitts, where there is no good clay, for it is of a coarse dark earth, soft and badly baked. The plate, size 8 in. by 7 in., is nearly complete; it is of the same material, and is ornamented with an

Fig. 3.

incised line winding round and ending in the curious spirally curved handle; there is a small perforated knob on the outside opposite the handle, apparently for a string to hang up the vessel. About fourteen of the fragments have been pieced together, making part of a large jar. From this I have restored the jar as in the sketch (Fig. 3). The dimensions were:—Diameter at brim $13\frac{1}{4}$ in., diameter at bulge $10\frac{1}{2}$ in., depth $12\frac{1}{2}$ in. It is of the red Nevis clay, apparently turned on a lathe, and well baked. The pattern is in white lines, and fired.

St. Kitts, W. I., March 30. C. W. Branch.

The New Education Bill and Local Museums.

I desire to call the immediate attention of those solicitous for the progress and improvement of local museums to the opportunity afforded by the Education Bill now before Parliament for obtaining some public recognition of their value in any scheme for the encouragement of secondary education. By some County Councils the Technical Instruction Act has been construed as permitting grants being made from the "Customs and Excise" funds to local museums, but other Councils have not so acted, and it is very desirable that this point should be definitely settled. All that would be required is the insertion in Section 12 (page 8 of the Bill as printed), and perhaps best at the end of Clause 2, of words giving power to the "Education Authority" to aid in the establishment and maintenance of museums, whether the property of a public body or a private society, provided that such museums are devoted to the instruction of the public, and are, of course, under such regulations and control as might be deemed necessary.

There can be little doubt, I think, of the valuable services which well-arranged local museums could afford to the work of technical instruction, more particularly in calling forth and encouraging a taste for natural science studies. But the great need of most of these small museums is an adequate and settled annual income sufficient to defray the cost of intelligent management. Capital sums for building, fittings, &c., would flow in, and donations of good local collections would often be made, if the fear of "want of permanence" could be allayed. It is this which is the difficulty in the management of local museums in the vast majority of cases, and a moderate grant of "technical instruction" funds in a county would often give far better results, educationally considered, than many of the objects to which this money is now applied.

The matter is by no means political or controversial—such grants would benefit many deserving institutions; and I hope that all well-wishers of museums will use their influence to get such a clause as that above indicated inserted in the Bill when before Committee. I commend the subject to the Museums Association and to the Secretaries of local scientific societies as one in which their energies would be most usefully exercised.

C.

A Bright Meteor.

WE had the good fortune to witness a splendid meteor here on Sunday evening, the 12th of this month. The sky was perfectly clear, the hour 8 p.m. The lady with whom I was walking, by an exclamation called my attention to it, so that I did not see it on its first appearance, but it must have started from the neighbourhood of α Draconis; it then pursued a south-easterly course, passing nearly parallel to ζ and η Ursæ Majoris and α Böotis or Arcturus, and disappearing at last behind a hill to the east. We did not, therefore, see its termination; but I hear from others who did, that there was no explosion. It must have taken several seconds in its flight, as there was time for my companion to make several remarks. Its size was very considerable, and its light intermittent. Three or four times it seemed as if about to be extinguished, but again blazed forth; the colour was a fine yellow, changing to crimson; a train of sparks followed it of about 5° in length. The whole path traversed could not have been less than 50°. In the evening twilight not many stars were visible, so that I was unable to determine its exact course as accurately as I could have wished.

J. D. LA TOUCHE.

Stokesay Vicarage, Craven Arms, Shropshire, April 14.

IT may be of interest to record the appearance of a fine meteor, the finest I remember to have seen, on the evening of Sunday, April 12, about 8.6 p.m. I was standing in a field in the parish of Mathon, on the extreme western border of Worcestershire, when a friend who was with me drew my attention to it. The meteor was then about 20° E. of N., and roughly half-way between horizon and zenith. It passed downwards and eastwards, very slowly as it seemed to us, till it reached a spot about 30° N. of E., and perhaps 20° above the horizon, when it disappeared. Its course was right underneath the Bear, which, lying east of the pole-star, was just becoming visible at the time. The time during which we watched the meteor I should estimate at from 10 to 15 seconds. The meteor consisted of a bright head appearing many times as large as Jupiter, and a train like a rocket's, but much shorter in proportion. The night, in the intervals of fierce north-westerly squalls, was exceptionally fine and clear.

West Malvern, April 16. A. G. TANSLEY.

A Daylight Meteor.

AT 7.25 a.m., April 18, a meteor was observed by an inmate of my house. The sun was shining clearly in an almost unclouded sky when, in looking up, three bright stars were seen in rapid succession shooting over the trees in a northerly direction. The person who made the observation was much excited with the sight, never having witnessed fire-balls of such brightness and rapidity before.

JAMES SHAW.

Tynron, Dumfriesshire.

"Rana esculenta" in Kincardineshire.

WHEN on a brief visit to Kincardineshire last month, I was surprised to find *R. esculenta* in considerable numbers at a few places which I visited. I found the frogs in pools beside the Bervie, and also in places several miles away. One of these was a small isolated bog. Mr. George Sim, of Aberdeen, who is well acquainted with the fauna of Kincardineshire, was unaware of the existence of this frog in the county until I called his attention to it. In 1837 and 1842 large numbers of these animals were introduced into England, but I have not heard of a similar introduction into Scotland. It does not seem probable that the frog should itself have migrated so far north. When a thorough examination of the district has been made, it may be found that the animal is widely distributed.

PHILIP J. WHITE.

University College of North Wales, Bangor.

THE RÖNTGEN RAYS.

THE investigations of M. Henri Becquerel on the radiation emitted by certain salts of uranium have shown the existence of a kind of radiation intermediate in its properties between light and the Röntgen rays. These investigations are exceedingly interesting on account of the differences as well as the analogies they disclose between the uranium radiation and the Röntgen rays. M. Becquerel has shown that the radiation from the double sulphate of uranyle and potassium is analogous to Röntgen rays, inasmuch as it can affect a photographic plate after penetrating substances such as aluminium, copper, wood, &c., which are opaque to ordinary light; it also resembles these rays in being able to discharge an electrified body, whether the charge be positive or negative. On the other hand, it differs from Röntgen rays and resembles ordinary light, inasmuch as it can be refracted and polarised. It is also much more easily reflected than Röntgen rays. The radiation from the uranium salts is thus intermediate in properties between ordinary light and Röntgen rays; and as there can be no question but that this radiation consists of transverse vibrations, inasmuch as it can be polarised, it affords strong presumptive evidence that the Röntgen rays are also due to transverse vibrations.

The persistence of the radiation from the potassium uranyle sulphate is very remarkable. M. Becquerel found that crystals which had been kept in the dark for 160 hours continued to radiate vigorously. This radiation is absorbed almost equally by aluminium and copper, so that it does not show the same dependence upon the atomic weight of the absorbing medium as that of the Röntgen rays; on the other hand, the radiation resembles Röntgen rays in not being homogeneous.

With respect to direct evidence of the Röntgen rays being due to transverse vibrations, such as would be afforded by a difference between the absorption by two plates of tourmaline (1) with their axes parallel, (2) with their axes crossed, the results are somewhat conflicting. On the one hand, Prince Galitzine and M. de Karnojitsky get a greater absorption through two plates of tourmaline when their axes are crossed than when they are parallel; while, on the other hand, M. H. Becquerel, M. Sagnac, and the writer get no appreciable difference between the two cases. It is just possible that as tourmaline is a mineral which varies greatly in chemical composition, those varieties which contain abnormal quantities of the heavier metals may show this effect, whilst in other specimens it may be too small to be appreciable.

A considerable number of experiments have been made to find the part of the tube where the Röntgen rays originate. Perrin, using pin-hole photography, came to the conclusion that they arise at the places where the kathode rays strike against a solid obstacle. Rowland, Carmichael and Briggs, on the other hand, using a very highly exhausted tube with the terminals only one millimetre apart, located the origin of these rays at the extremity of the *anode*. Prince Galitzine and M. de Karnojitsky place the origin inside the tube some millimetres behind the glass. The writer, with the assistance of Mr. McClelland, investigated this point by measuring the rate at which electricity leaks through an air space of fixed length at different distances from the bulb; the Röntgen rays passing through a small hole in a thick plate of metal. The rates of leak were found to vary inversely as the square of the distance from a point, but the position of this point with respect to the tube varied with the shape and character of the tube used to produce the rays. When the bulb was pear-shaped, with the negative electrode in the narrow part of the tube, the point was near the place where the bulb began to widen out; while with bulbs containing metallic plates to reflect the rays, this origin of the rays was on the metal plate whatever might be the position of the negative electrode. But in no case did the origin of the rays fall on the part of the tube nearest to the air space through which the leakage was measured, though this was the part of the tube which was most brightly phosphorescent. The origin, however, in these experiments was always at a place where some kathode rays struck against a solid obstacle. In these experiments the rays came through a small hole, so that the want of coincidence between the origin of the rays and the part of the tube where the phosphorescence was brightest, could hardly be explained by supposing that the direction of emission of these rays is practically almost confined to the normal to the phosphorescent surface, so that the apparent source of the rays would be the locus of intersection of the normals to this surface.

The results of the various investigations as to the source of the rays seem to show that this is most commonly at a place where some kathode rays strike against a solid obstacle; they also prove that there are regions in the tube where, though many kathode rays are stopped, very few Röntgen rays are produced. The experiment of Rowland previously mentioned, as well as the one by Lord Blythswood, where the rays were produced at the negative terminal of a Wimshurst machine without a bulb at all, suggest that there are other sources of these rays besides places where solids are bombarded by kathode rays. Judging from analogy with the behaviour of an ordinary discharge tube giving a luminous discharge, there seems nothing unreasonable in the idea that these rays may sometimes originate in the gas itself by the splitting up of its molecules under the electric discharge. When the discharge is luminous there is, as Dr. Schuster has pointed out, generally a peculiar spectrum emitted by the negative glow outside the negative dark space; there is thus in this region, under the comparatively feeble electric field which can exist when the discharge is luminous, some process going on which is favourable to the emission of radiation. Now, when the tube is emitting Röntgen rays the dark space reaches to the walls of the tube, and the intensity of the electric field is enormously greater than when the discharge is luminous. (It is most interesting to connect a voltmeter to the terminals of a tube while it is still on the pump, and observe the way the readings go up when the tube is getting into a fit state to emit Röntgen rays.) It would seem likely that under this very intense electric field the gas in the tube would be more thoroughly split up than under the feeble field which accompanies the luminous discharge, and that this finer subdivision of the gas would cause the emission of radiations of much smaller wave-length. It would be interesting to investigate whether the nature of the gas in the bulb has any effect upon the character of the Röntgen rays emitted by it; it would, however, be necessary to use other pumps as well as mercury ones to try this experiment.

The existence of a definite metallic reflection, which is considerable at grazing incidences, has been proved by Dr. Joly; while Lord Blythswood and other experimenters have published accounts of investigations which confirm Röntgen's observation of a copious diffuse return of rays from a solid obstacle. The definite metallic reflection gives us hope of arriving at the wave-lengths of these rays by interference experiments with metallic mirrors inclined at a small angle, though before this experiment can be successfully attempted it will be necessary to study more closely the want of homogeneity in the Röntgen rays, and to devise methods of producing monochromatic rays. From an interference experiment with negative results, M. Sagnac concludes that the Röntgen rays he was using must have had a wave-length less than 4×10^{-8} centimetres.

A very remarkable experiment has been made by M. Lafay, in which effects are produced similar to those which would occur if under certain circumstances the Röntgen rays were absorbed, and rays having the property of being deflected by a magnet emitted. The experiment is as follows: a photograph of a needle is taken through a thin piece of silver-foil; the Röntgen rays, after passing through the foil, traverse a magnetic field. If the foil is not electrified, the magnetic field produces no effect on the position of the shadow of the needle; when, however, the foil is electrified (by a source quite independent of the one used to work the coil), the shadow is deflected when the magnetic field is on, the direction of deflection is reversed when the sign of the electrification of the foil is reversed. Only a preliminary account of this experiment has yet been published, and in this it is not explicitly stated whether or no the width of the shadow cast by the needle is affected by the magnetic field. The point is an important one in the interpretation of this experiment, for the Röntgen rays, falling on the charged silver foil, will discharge its electrification and produce electric currents in the air; these currents, probably in this experiment flowing somewhat in the direction of the rays, would, when they passed through the photographic plate, probably affect it. Now these currents will be deflected by a magnet, the magnet driving some of them on to the part of the photographic plate previously occupied by the shadow of the needle. They would thus encroach on one side of the shadow; they would not, however, affect the other side unless the Röntgen rays were stopped by the charged plate; as though these currents can obliterate a shadow, they could not produce one where the Röntgen rays are present. Thus the effect of the currents would be to cut a piece off the shadow, and the piece would be cut off from one side or the other, according as the silver-foil was positively or negatively electrified. These currents, however, could not, with the presence of the Röntgen rays, explain a simultaneous shifting of both sides of the shadow of the needle.

Röntgen's discovery of the close connection between the absorption of these rays and the atomic weight of the absorber, has been confirmed and extended by many observers. This is a most interesting result, and it may be remarked is what would occur on Prout's hypothesis of the constitution of the elements, if each little primordial atom furnished its quota to the absorption of these rays.

The rate of leakage of electricity through different gases under the influence of these rays has been measured by Mr. McClelland and the writer. We find that in general the rate of leakage increases with the atomic weight of the gas, although there are exceptions to this rule. The rapidity with which electrification leaks through the halogens is very remarkable; it is interesting to find that the gas through which the rate of leak was greatest was mercury vapour, although the ordinary electric discharge only passes through this gas with great difficulty. When leakage takes place between two platinum plates in a gas exposed to these rays, the plates show strong polarisation.

The connection between the rate of leak through a gas and the potential difference is very remarkable. When the potential difference does not exceed two or three volts, the rate of leak is proportional to the potential difference. Then increasing the potential difference, we arrive at a stage where the rate of leak increases more rapidly than the potential difference. Increasing still further the potential difference, we soon arrive at a stage where the rate of leak is almost independent of the potential difference. Thus in chlorine we found that the rate of leak was practically the same when the potential difference was 278 volts as when it was ten. The relation between the rate of leak and the potential difference thus exhibits the same general features as that between the magnetisation of a piece of soft iron and the magnetising force.

This result seems to throw light on the manner in which the electricity passes through the illuminated gas, and may perhaps be extended to conduction through ordinary electrolytes.

M. Stoletow has observed a somewhat similar relation between the potential difference and the rate of leak from a negatively electrified surface illuminated by ultra-violet light.

Mr. McClelland and I also investigated the connection between the rate of leak and the potential difference in the case of solid dielectrics, such as paraffin and sulphur exposed to the Röntgen rays. We found that this obeyed Ohm's law up to the highest potential difference (278 volts) used in our experiments, so that the potential difference required to "saturate" solid delectrics is evidently very much greater than for gases. The polarisation is also much greater for paraffin and sulphur than for gases, and it can be locked up, as it were, in the dielectrics for any length of time by screening them from the rays

J. J. THOMSON.

THE EXPERT WITNESS.

WE are rejoiced to see the daily press at last calling attention to the need of reform in the present system of expert witnesses, indicating that public opinion is coming round to the view which we have advocated for the past twenty-five years. The fact that scientific men, some of them even of high standing, can be procured to sustain the most contradictory views is, we have no hesitation in saying, hurtful to the interests of science, and tends to degrade science in the opinion of the public.

An easy way to secure perfectly unbiassed opinion is to insist that a scientific expert should not be called by a particular side in a case, but should be nominated by the Judge. We have urged the expansion of this system from the Admiralty Court, in which it is constantly employed, and within the past few days our opinion has been echoed by the daily press.

Commenting upon the judgments in two actions brought by the Incandescent Gas Light Company against rival companies for infringement of Dr. Welsbach's patent, the *Times* says :—

"One reflection is likely to occur to any who has watched the progress of these cases. The substantial question to be determined was one of chemistry and chemical history. The principle of law to be applied was clear and simple. A cloud of scientific witnesses was in attendance, and men of great eminence, such as Sir Henry Roscoe and Prof. Dewar, were called on both sides. The objection to this course is not perhaps very serious when the litigants are wealthy companies and the patent is of great value. But it must strike any impartial mind that the length of such inquiries would be curtailed, that the expert would be more in his true place than he often now is, and that there would be fewer exhibitions of startling conflicts between the opinions of high scientific authorities, if the Court frequently did what it is not customary to do—namely, took the evidence more into its own hands, nominating one expert, or it may be two, to report for its guidance on some of the matters of controversy. An expert reporting as the delegate of the Court would sometimes express himself very differently from one paid for his evidence, and many cases would occupy as many hours as they now occupy days."

The *Globe* also has something to say in condemnation of the present state of things, and its plain words will not be pleasant reading to men imbued with the true scientific spirit. Referring to the same cases as the *Times*, it remarks :—

"From the conflict of expert testimony, which is almost invariable in these cases, an idea has grown up that such evidence is not very valuable to the plain man, and the average juryman is much disposed, when he hears the eminent experts contradicting one another, to pay little or no attention to either side. The fact is that our whole system of taking expert evidence is founded on a wrong basis, except in the Admiralty Court, where the Judge has the advantage of professional opinion from persons occupying a quasi-judicial position. The expert who is called in an ordinary case receives a fee which varies according to his reputation, and also according to the length he is prepared to go in supporting the case of those who call him. Naturally, a plaintiff, whose case depends upon, say, a doubtful point in chemistry will search for an expert witness who takes that view of the question which is most favourable to his contention, and the defendant on his side, will look for one who does exactly the reverse. Hence there is a continual pressure being exerted upon the expert witness to go further in his evidence than would be the case if he could be impartial, and testimony becomes bewilderingly contradictory. A simple remedy for this state of things would be for the Judge to select the expert himself. There are few departments of science in which he would not know of some recognised authority, and, even if he did not, he could always obtain the information. An expert so chosen would, of course, receive his fees from the suitors, but he would give his evidence as the assessor of the Court instead of as the witness of one litigant, the truth would be much more easily got at, and cases that now take weeks would be settled in a few days."

As in most matters with which science is concerned, Germany is able to show us the best mode of action. Experts are appointed by the State at the discretion of the Judge; these may be men not suggested by either of the litigants, or chosen by both of them.

It has been legal in England for some years for a Judge to select an expert to report to the Court upon a particular matter in dispute, and this practice is occasionally followed. There is thus little difference between the status of the official English expert and the expert of the Imperial Courts in Germany. All that is needed is the substitution of official experts entirely for those called by the parties concerned. Under such a system, no question of bias could be raised, and science would not be scandalised from time to time as it is now by those who are content thus to trade on their scientific reputation, and give rise to such unpleasant insinuations as those in which the *Times* and *Globe* are pleased to indulge.

H. C. LEVINGE.

BOTANIC science has sustained a loss by the death, in the full vigour of middle life, of H. C. Levinge, of Knock Drin Castle, Mullingar, late Secretary to the Government of Bengal (Public Works). During his Indian career he devoted all the time he could spare from official labour to natural history, and especially to the vascular cryptogams. His collection of Indian ferns was the largest and finest hitherto made; he had himself explored more particularly Sikkim, Kashmir, the Neilgherries, and the mountains south therefrom. At the very time when, on retiring home, he was preparing to work on his superb collection, the larger and finer part of it was destroyed in the fire of Whiteley's fire-proof warehouse. From this cause, and perhaps from the excellence of the late work of Colonel Beddome on Indian ferns, Mr. Levinge, at Knock Drin Castle, devoted himself chiefly to the Irish flora. He contributed several papers to the *Irish Naturalist*, and to the *Journal of Botany*; and added no less than seventy-seven additional species to area vii. of the *Cybele Hibernica*. Most of these were from West Meath, many from the immediate neighbourhood of Knock Drin. They are mainly critical or easily overlooked species as *Chara denudata*, Braun (new to the British Isles); he also discovered new localities for many very rare plants, as for *Neotinea intacta*, Reich, f.; for which see his paper in *Journ. Bot.*, 1892, p. 194. Among his Sikkim collections he found a small undescribed *Selaginella*, in which the macrospores are covered with hairs (perhaps only extensions of the tubercles frequently present) exceeding the breadth of the macrospore—an extraordinary morphologic example of the possibilities of unicellular development, and also of interest to the student of fossil botany, where similar, possibly Lycopodiaceous, spores occur.

Botanists, strangers to Mr. Levinge, who called at Knock Drin Castle, were received with domestic and scientific hospitality at once; they were instructed by the beautiful gardens; they were expedited to all the best collecting grounds in Westmeath and neighbouring counties, and the interesting plants put in their hands. His friends will unanimously agree that no more delightful man remains behind him. It is understood that he has bequeathed his collection to the Dublin Museum of Science and Art. C. B. C.

NOTES.

The French Academy of Medicine has decided to divide between Dr. Roux and Prof. E. Behring the 250,000 francs prize, founded by M. and Mdme. Victor Saint Paul as a reward to whomsoever should first discover a remedy for diphtheria.

We regret to have to record the death of the Moscow Professor of Zoology and Anthropology, Anatoly Petrovich Bogdanoff. He was born in Southern Russia in 1834, and after studying at the Moscow University, and writing, in 1858, his first dissertation on the colours of birds, he became Professor of the same University in the year 1863. In connection with this work he wrote an excellent text-book of zoology, and a still better work, unique in its kind, namely, a "Chrestomathy of Zoology," in three volumes, in which the reader obtains a thorough scientific acquaintance with the different classes of the animal kingdom by means of admirably chosen abstracts from the best authors, considerable attention being given to purely biological questions, and especially to the lowest animals, as well as to their manners of life. A couple of generations of Russian zoologists have been indebted to this admirable work. In the sixties, Prof. Bogdanoff founded, at Moscow, the well-known "Society of Lovers of Natural Sciences, Anthropology and Ethnography," whose numerous quarto volumes of *Memoirs* rank among the best scientific publications in Russia; and whose expeditions included the well-known Turkestan expedition of the late Fedchenko and Madame Olga Fedchenko. The chief anthropological work of A. P. Bogdanoff was on the inhabitants of the grave-mounds of the Moscow region. The full list of his nearly forty anthropological, and nearly thirty zoological works is given in the most valuable publication, "Materials for the History of Zoology, pure and applied, in Russia, chiefly for the last Thirty Years," of which he was the editor, and of which three volumes have already been published. His works for popularising biology, especially on Darwin's ideas, and for extending the interest in anthropology, are also numerous.

The sixty-eighth meeting of German Naturalists and Physicians will be held this year at Frankfort-on-Main, from September 21 to 26.

Our American correspondent writes, under date April 10: "Mrs. Elizabeth Mary Ludlow, mother of the late Robert Center, has given his estate, valued at 150,000 dols., to Columbia College as an endowment of 'The Robert Center Fund for Instruction in Music.' An anonymous friend has given 10,000 dols. to be expended in the purchase of books for the library. The Havemeyer family have given to Columbia College a fund as a memorial to Frederic Christian Havemeyer, with which the finest building in America for the study of chemistry will be erected, at a cost of nearly 500,000 dols. on the new site of the college. The building will be 80 × 208 ft., and four stories high. It will be finished in hard enamel, with floors of asphalt; and the corners of all rooms will be rounded so as to prevent accumulation of dust and disease germs, and the drainage system will permit every room to be washed out with a hose. Work is rapidly progressing on the other buildings, the library, the hall of physics, and Schermerborn Hall, which is devoted to natural sciences. Plans for the hall of engineering have been approved, and ground broken. The site of the chemistry building will be dedicated on May 2."

The conditions of the 1100 guineas road carriage competition have now been settled by the proprietors of the *Engineer*, and are announced in the current number of our contemporary. An arrangement has been made with the Crystal Palace Company, who have offered facilities at the Crystal Palace for showing the carriages in work there, and for holding the subsidiary trials. The judges will be Sir Frederick Bramwell, F.R.S., Mr. J. A. F. Aspinall, and Dr. John Hopkinson, F.R.S. The competition is to be international. The vehicles will be divided into four classes and one supplemental class, in each of which a prize will be given, as follows:—(*a*) For the best mechanically propelled vehicle constructed to carry (including the driver) four or more persons, the total weight, when fully loaded, not exceeding two tons, a prize of 350 guineas; (*b*) for the best mechanically propelled vehicle constructed to carry either one or two or three persons, the total weight, when fully loaded, not exceeding one ton, a prize of 250 guineas; (*c*) for the best mechanically propelled vehicle constructed to carry, in addition to the driver, not more than one ton of goods or parcels, the total weight, when fully loaded, not exceeding two tons, a prize of 250 guineas; (*d*) for the best mechanically propelled vehicle constructed to carry, in addition to the driver, five hundredweight of goods or parcels, the weight, when fully loaded, not exceeding one ton, a prize of 150 guineas. (Supplemental).—For the vehicle, whether for passengers or goods, propelled solely by a motor actuated by the vapour of oil or spirit, having a lower specific gravity than 0·8, or a flashing-point lower than 73° F., Abel's test, and constructed to satisfy the requirements of any Act of Parliament, and the rules to be made thereunder for the time being respectively in force, which, in the opinion of the judges, best satisfies the purpose for which it is built, a prize of 100 guineas. Any method of propulsion other than muscular power may be employed, provided it be contained in the vehicle. Entries are to be made on printed forms (to be obtained at the offices of the *Engineer*) at any time prior to 6 p.m. on the last day of July, 1896. Preliminary runs will be made in the grounds of the Crystal Palace with each of the vehicles in succession. The practical working run will consist of a run on the public roads of not less than 100 miles out and 100 miles home, or a total of not less than 200 miles over a course to be announced three days prior to that fixed for the run. It will probably be arranged for Monday, October 12. Any vehicle which does not complete the "practical working run" at a *minimum* average speed of five miles an hour, to include all stoppages, to be disqualified.

In reference to the article on "The Tick Pest in the Tropics," contributed by Mr. C. A. Barber to these columns last June (vol. lii. p. 197), Dr. M. Francis, Veterinarian of the Texas Experiment Station, has drawn our attention to an account by him of the method of destroying ticks on the cattle of Texas, and, as the study of the tick pest is one of his principal duties, this description is of great value. After several unsuccessful attempts to destroy the pest by various means, the dipping process has been adopted at Texas with very gratifying results. A large vat of five thousand gallons capacity is used, and the cattle are forced to swim through it. Various carbolic and arsenical sheep-dips were employed as solutions in the vat, but the results were not satisfactory; either the cattle had to be kept in the dips for too long a time in order to kill all the ticks, or they were irritated by the solutions. This led Dr. Francis to try the effect of oil in destroying the ticks. It is well known that grease or oil, of almost any kind, is fatal to insects, lice, &c., and known facts as to the life-history and structure of ticks gave presumptive evidence that oil might be successfully substituted for the various commercial dips which had been employed. A layer, from three-quarters to one inch in thickness, of crude cotton-seed oil on the water in the vat was first used, the cattle being forced to swim through the vat, so that when they emerged they were covered perfectly with oil. This had no apparent effect on the cattle, but was found to be exceedingly fatal to the tick, and was very much superior to any other treatment tried. Dips of different nature were experimented with, but none as yet used have given such satisfactory results as the cotton-seed oil. Kerosene emulsion was found to have no practical value; crude petroleum irritates the skin, and emulsifies with water; resin oil is useless for the purpose; corrosive sublimate is too dangerous and is not very fatal to ticks even in solution 1 : 250 in water; and tobacco sheep-dips have no practical value. Dr. Francis is at present studying the effects of other oils, the most promising being West Virginia Black, a mineral oil. A full description of the construction of the vat and pen enclosure used will be found in the *Texas Farm and Ranch* of March 14.

CARNATION-LOVERS will read with much interest a *Bulletin* just issued from the Agricultural Experiment Station of Purdue University. It is entitled "Bacteriosis of Carnations," and describes in great detail an elaborate investigation which Messrs. Arthur and Bolley have carried out on a disease with which carnations are very frequently afflicted. That this disease is caused by true parasitic bacteria, these researches appear to prove beyond doubt, and Messrs. Arthur and Bolley have succeeded in isolating the specific microbe, which they have named "Bacterium Dianthi." Although this bacillus grows readily in artificial culture media when rendered acid, producing a yellow pigment, it has only been found in nature in leaves of the carnation-pink, and infection experiments seem to indicate that it is parasitic only upon pinks, and produces no effect on the shoots, leaves, or tubers of potatoes, or on other non-caryophyllaceous plants. The disease seems to be started by these bacteria entering the plant from the air through the stomata, or occasionally by means of punctures made by aphides; whilst their passage from one cell to another is due, in the opinion of the authors, to the secretion of an enzyme, by means of which the microbe "dissolves for itself a passage-way." Although no varieties of carnation are exempt from the disease, yet they differ greatly in their susceptibility towards it. Delicate varieties and poorly-grown plants are more readily affected than vigorous and well-grown varieties. It is satisfactory to learn that such a simple precaution as keeping the foliage dry, and preventing the presence of aphides, may practically banish this disease from our carnation-houses.

A CORRESPONDENT of the *Times* says:—"Within the last few weeks there has been in connection with the Dover Coal-field a transition from the experimental to the practical stage. In the last week of March the Kent Coal-fields Syndicate was formed, the capital of which was fixed at £200,000, and last week the whole of that capital was subscribed, a board of directors chosen, and a contract entered into for the sinking of two shafts as near as practicable to the Shakespeare's Cliff boring, it being stipulated that these two shafts are to be carried down to 2 ft. in. seam (1138 ft.) within eighteen months, and equipped with the most approved machinery capable of winding 2500 tons per day."

A "RECORD" has been accomplished in measuring geodetic base lines by the Swedish surveyor Jäderin. The French staff officers, using double bars of two metals and microscopes, consider 400 metres per day good work. Hatt, in Corsica, using an encased steel ribbon 20 metres long, stretched on stands by two weights of 8 kilogrammes, advanced 500 to 600 metres per day. But Jäderin, by employing successively two wires, one of steel and the other of bronze, stretched by spring dynamometers at a tension of 10 kilogrammes, and supported on ten tripods, succeeded in measuring up to 3 kilometres in one summer-day—whether at midsummer, north of the Arctic Circle, we cannot say. From the notice which appears in the current number of the *Physical Society's Abstracts*, we learn that Jäderin's paper has not been printed.

IN a valuable paper (*Atti e Memorie della R. Accad. di Scienze* in Padova, vol. xii., 1896, pp. 89–97), Prof. G. Vicentini has presented an interesting summary of his investigations on earthquake pulsations. The instrument employed is the microseismograph designed by himself (see NATURE, vol. li. p. 540), and now erected in the Universities of Siena and Padua. The motion of the paper on which the pulsations are recorded is unusually rapid, and this has allowed a detailed examination of their nature to be made. Prof. Vicentini distinguishes, as a rule, three phases in each disturbance. The first consists of rapid vibrations and small oscillations; the second of large, and more or less irregular oscillations, with several maxima which begin and end abruptly; in the third phase the pulsations become more regular, and are longer in period. Throughout nearly the whole movement, but especially during the last two phases, the mean position of the pendulum generally undergoes a continuous change, showing that with the more rapid oscillations there coexist long, slow waves with a period of at least twenty seconds, which result in a gentle tilting of the surface of the ground. If the earthquake is a severe one, and the origin at a great distance from the place of observation, the three phases are separated from one another. But, as the distance of the epicentre diminishes, the first two phases partly coalesce, and the rapid vibrations are superposed on the earlier long-period oscillations. When the earthquakes are weak and of local origin, the tilting of the ground is still observed. During the slight Rovigo earthquake of May 25, 1895, for instance, the tilting at Padua took place nearly in a straight line, slowly in the first ten seconds, but more rapidly in the next twelve, when it reached a maximum of about 6″. After this, for ten seconds, an equally rapid tilt took place in the opposite direction, and this was succeeded by several smaller oscillations, of about twenty seconds each, before the motion became imperceptible.

FROM the Horticultural Department of the Cornell University Agricultural Experiment Station we have a "Geological History of the Chautauqua Grape Belt," a narrow plain in the State of New York, extending north-eastward from the Pennsylvanian State line, bounded on the north by Lake Erie, and south by a high range of hills, well adapted for the culture of the vine.

THE Department of Entomology of the U.S. Department of Agriculture has issued an account of the San José Scale, its occurrences in the United States, and the remedies to be used against it, by Mr. L. O. Howard and Mr. C. L. Marlatt. As many as twenty-eight different kinds of trees and shrubs are enumerated as being liable to the attacks of this pest, including most of the common fruit trees, a few varieties of pear only being exempt.

THE "jack-rabbits" of Southern California and the adjoining States appear to be nearly as great a nuisance in America, as the ordinary rabbit in Australia and New Zealand. A lately published number of the *Bulletin* of the U.S. Department of Agriculture is devoted to a report, prepared by Dr. T. S. Palmer, on the jack-rabbits and their ravages, and on the best manner of getting rid of them, which is said to have become of late years a serious question in California, Colorado, Idaho, Oregon, and Utah. The so-called "jack-rabbits" belong to five species of the genus *Lepus*, which are spread over Western America from the plains of the Saskatchewan down to Mexico. They live on the open prairies, and, as they do not burrow, are compelled to trust for safety on their quickness of hearing and speed. Their ears and hind legs have been developed accordingly to an extraordinary degree. In some places they multiply to such an enormous extent that the damage done to the crops in one single county in California has been estimated at 600,000 dols., and one county in Idaho has expended more than 30,000 dols. in bounties paid for their destruction. The most effective mode of getting rid of jack-rabbits appears to be by driving them over a large tract of country into a "coral." On each side of the coral two long wings of wire-fencing are run out, and in some cases are extended to a length of six or seven miles on each side. The whole population of the country is then collected on a special day and a line formed, in order to drive the rabbits between the wings of fencing into the coral. In some cases these drives are carried out on a gigantic scale, and the number of rabbits destroyed on a single occasion runs up to 20,000. Upon the appointed day large numbers of people turn out, armed with sticks and clubs, and, scattering over a considerable area, start the rabbits and drive them towards the mouth of the coral. Every available vehicle is pressed into service, but the larger part of the throng is usually on foot. The lines gradually close in, and the frightened rabbits, urged on by blows and shouts, rush blindly into the opening between the wings, and are gradually despatched with clubs. The *Bulletin* contains a table, which shows that upwards of 370,000 "jack-rabbits" have recently been destroyed in this manner.

Result of the Grand Army Rabbit Drive at Fresno, California—20,000 Jack Rabbits killed.

THE last *Bulletin* received (vol. ii. No 6) of the Imperial University College of Agriculture (Tōkyō) contains important papers (in German), all relating to the culture of Conifers, by Prof. O. Loew and Dr. Seiroku Honda.

MESSRS. HENRY HOLT AND CO. announce, among their forthcoming works, "Electricity," by Prof. Charles A. Perkins, of the University of Tennessee, and "A Problem Book in Elementary Chemistry," by E. Dana Pierce, of the Hotchkiss School, Lakeville, Ct.

THE Field Columbian Museum has issued a Flora of West Virginia, by Mr. C. F. Millspaugh and Mr. L. W. Nuttall. Besides Flowering Plants the list includes the Vascular Cryptogams, Muscineæ, and Fungi; a considerable number of new species of Fungi being described. While commending the activity of this energetic Western station, we would venture to suggest, in future publications, a somewhat more careful revision of the press. Such names as *Equisitæ*, *Lycopodæ*, and *Impomæa* do not look well in a scientific publication.

WE have received the Summary Report of the Canadian Geological Survey, for 1895. Although strict economy has been rendered necessary, much good exploring work appears to have been done. The deep boring for oil at Athabasca Landing has now been continued down to over 1700 feet, with every prospect of early success when work is resumed this season. Students of Graptolites will welcome the announcement that Prof. Lapworth's work on the Canadian forms is now approaching completion.

IN a communication made before the St. Petersburg Society of Naturalists (*Proceedings*, November 1895), Prof. Borodin described some interesting species of plants which he had discovered during his last summer's exploration of the lakes of the Valdai plateau, namely, the *Isoëtes echinospora* and the *Isoëtes lacustris*, the *Lycopodium inundatum*, *Botrychium virginianum*, and *Luzula angustifolia*, Garcke, var. *albida*, which last seems to have been imported, and now grows in masses along the embankment of the Moscow Railway. He especially mentioned the simultaneous occurrence, in Lake Bologoye, of the two species, *Caulinia fragilis*, W. (*Najas minor*, All.) and *Caulinia flexilis* (*Najas flexilis*, Rostk.), which, Prof. Borodin remarks, never occur together. The former is known from many localities of Southern and, partly, Middle Russia; but the second, which is altogether a rare northern species, has only been found until now in the lakes of Finland and Olonets.

THE presidential address, delivered last December to the Geological Society of Washington, by Dr. G. K. Gilbert, has been published by the Society. It is entitled "The Origin of Hypotheses," and illustrates the methods of scientific investigation by reference to a particular problem—the origin of the peculiar crater-structure in limestone known as Coon Butte (Arizona). Involving as it does a consideration of all possible methods of the formation of a non-volcanic crater, it will be found to have a more special interest for geologists than the title might suggest.

THE Rugby School Natural History Society is one of the best of the scientific societies attached to our public schools. The report for the year 1895 has just come to hand, and we recognise in it a spirit of devotion to science worthy of the fullest encouragement. It is no small matter for a school society to spend £270 upon the purchase of objects, cases for a new museum, and for the rearrangement of the specimens; yet that is what the boys at Rugby have done. A rigid economy of many years enabled the Society to meet the entire expenses of the removal and cleaning of the objects, without appealing for help from outside, but as a consequence its resources are entirely exhausted. Funds are needed to be devoted to new cases for the entomological collection in the museum, but, we understand from the report, unless material assistance beyond the ordinary income is received, it will be a long time before the Society's exchequer will be sufficiently replenished to warrant any expenditure. We cordially commend the position of the Society to philanthropists, believing that any assistance given would work for the increase of scientific investigators. The papers contained in the report are on the flight of birds, by Mr. W. T. Loveday; the contents of the Rugby School Museum, with suggestions for their improvement and enlargement, by Mr. W. E. Collings; the functions of a school natural history museum, by Mr. L. Cumming; and on earth-worms, by the Rev. Hilderic Friend. There are also the usual reports of the various scientific sections of the Society.

THE additions to the Zoological Society's Gardens during the past week include a Red-faced Ouakari (*Brachyurus rubicundus*), from the Upper Amazons, presented by Mr. Ernest E. Austen; a Black-eared Marmoset (*Hapale penicillata*), a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. R. H. Biddle; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Captain Hyde and Mr. James Green; a Lion (*Felis leo*, ♂) from Africa, deposited; an Indian Civet (*Viverricula malaccensis*) from India, a Nankeen Night Heron (*Nycticorax caledonicus*) from Australia, twenty Midwife Toads (*Alytes obstetricans*) European, purchased; a Weka Rail (*Ocydromus australis*) from New Zealand, received in exchange; two Maholi Galagos (*Galago maholi*), four North African Jackals (*Canis anthus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

URANUS AND ITS SATELLITES.—As part of his work at Mount Hamilton during 1894 and 1895, Prof. Barnard took up the measurement of the positions of the four moons of the planet Uranus, and his results have just been published (*Astronomical Journal*, No. 370). Even with the 36-inch telescope the two inner satellites were usually difficult objects, while Titania and Oberon were also difficult if there was any wind to disturb the telescope. Ariel seems to be generally about half a magnitude brighter than Umbriel, and is the more easily visible notwithstanding that it is nearer to the planet. The compared brightnesses of Titania and Oberon seemed at first to show a variation of their relative light, amounting to a whole magnitude, but it is by no means certain that a real change occurs in the brightness of either; a consideration of the circumstances under which the comparisons were made has led Prof. Barnard to the curious conclusion that his eye has a tendency to make the lower of two equal lights appear the brighter, and he therefore thinks it probable that the two outer satellites are of constant and nearly equal brightness.

Apparently without being aware of the earlier observations of Schiaparelli and others, Prof. Barnard noticed a very decided ellipticity of the disc of Uranus, and found that the orbits of the satellites deviate some 20 or 30 degrees from the equatorial plane indicated by the major axis of the disc. For the polar and equatorial diameters, the measured values are 3″·93 and 4″·150 respectively, when reduced to the mean distance of Uranus from the sun equal 19·18329 astronomical units. The polar compression appears to be greater than that of Saturn, which fact indicates a rapid axial rotation. The mean diameter of the planet derived from the measures is 34,900 miles.

COMET SWIFT.—A telegram received from Kiel on April 17 announces the observation of Swift's comet at 8h., Echo Mountain mean time, on April 13 in R.A. 3h. 39m., Decl. 15° 40′ N. The comet is stated to have a tail, and was moving slowly westward. It is a little south of the Pleiades, so that it can only be observed for a short time after sunset.

A later telegram states that the comet was observed at the Lick Observatory at 8h. 26m. mean time on April 16; it was then in R.A. 3h. 38m., Decl. 18° 20′ N.

THE ASTRONOMICAL AND PHYSICAL SOCIETY OF TORONTO.—Judging by the sixth annual report, which we have just received, this Society is doing good work in popularising the study of science in Canada. The volume contains reports of the semi-monthly meetings and a series of papers read before the Society. For the most part the papers give popular accounts of various astronomical and physical researches, among which "the spectra of nebulæ," "celestial photography," and "electrical radiation" may be specially mentioned. One of the communications, by A. Harvey, describing the behaviour of minerals at very high temperatures, is very suggestive. His experiments were made by means of a Barton electrical furnace, in which the current proceeds through water to the negative pole, so that an arc is formed where the mineral at the negative pole is brought to the surface of the water. The mineral in this way becomes surrounded by an intensely heated gaseous envelope, and its surface is quickly melted, while a brilliant light is produced. When removed from the water, the crust on the surface of the mineral greatly resembles that seen in meteorites. Different minerals give out light of different colours, and usually glowing particles are detached in very much the same way as those which give rise to the trails of shooting-stars. The volume also reports the proceedings of the Committee on the "unification of time." It appears that of the nine nations publishing ephemerides, six have formally given their assent to the proposal that on and after the first day of January 1901, the astronomical day should begin at mean midnight.

PHYSICAL PHENOMENA OF THE HIGH REGIONS OF THE ATMOSPHERE.[1]

THE first and decisive cause of nearly all physical phenomena occurring in the terrestrial atmosphere is the solar heat. The atmosphere may therefore be considered an immense heat machine, of which the sun is the focus; the boiler is represented by the soil or the clouds heated by its rays, and the condenser by the radiation towards the interplanetary space.

The means by which physicists and meteorologists study the various regions of the atmosphere are very limited; they are obliged to content themselves, more often than not, with very indirect observations, and to proceed by induction. In fact, the most interesting phenomena occur in the high regions—that is to say, at almost inaccessible heights. The object of this lecture is to show by some experiments that meteorological physicists are beginning to approach very closely the real explanation of natural phenomena. You will see, in fact, that in certain cases, not only an exact image of these phenomena is obtained, but often a veritable synthesis of them may be produced by the employment of processes entirely analogous to those which really operate in nature.

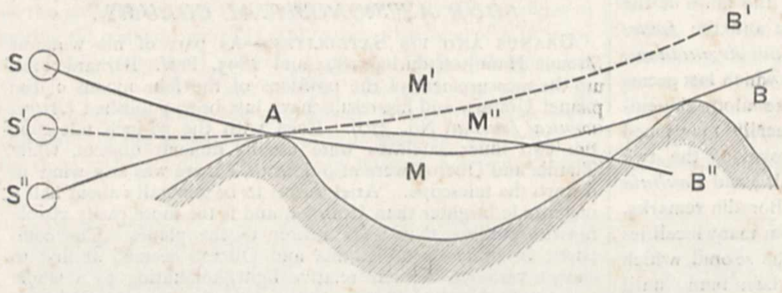

FIG. 1.

I will begin by enumerating the means in use amongst meteorologists for studying the different regions of the atmosphere.

The most direct method is the use of the aerostat; the aerostat or balloon makes it possible to take instruments of measurement to the very heart of the atmospheric regions one wishes to study. Unfortunately the method is difficult, expensive, and also dangerous; it is therefore only used in exceptional cases. The balloon ascents which have resulted best are those of Gay-Lussac (1804), of Glaisher (1862), and recently of Dr. Berson, of Strassfurt (1894), who ascended more than 9000 metres.

The most important facts observed in the balloon were very unexpected; here is the *résumé* of them:

(1) There exist very frequently clouds formed of *crystals of ice;* they constitute the cirrus, which float at very great heights.

(2) The *direction* of the *wind changes* at different heights.

(3) The temperature does not always diminish regularly with the altitude; very often *cold layers* and *hot layers* are met with *alternately*.

The second direct method for studying the atmosphere is the constructing of mountain observatories, as much as possible on isolated peaks. In these observatories the reality is daily verified of these unforeseen *inversions* of *wind* and *temperature* at different altitudes.

As for the clouds of ice, they are too high to be attained directly by the mountain observatories.

It will, perhaps, be interesting for you to know the principal mountain observatories constructed in France.

[Projection of the photographs of the following observatories:

Pic du Midi	(altitude 2800 metres)		in the Pyrenees.
Mont Ventoux	,,	1900 ,,	in Provence.
Puy-de-Dôme	,,	1900 ,,	in Auvergne.
The Eiffel Tower	,,	330 ,,	in Paris.

This last observatory, owing to the lightness of its construction, entirely in open work, may almost be considered a captive balloon, permanent and fixed, 300 metres above the ground.]

Halos.—We have said that mountain observatories do not attain the region of the clouds of ice (6000 to 10,000 metres in altitude); it would, therefore, be only possible to observe them in a balloon. Fortunately these crystals of ice reveal themselves by an optical phenomenon, *the halo*, which is even seen from the low levels. It is a brilliant circle, with radius of about 22°, which encircles the sun or moon; it has a reddish tint inside, and slightly bluish tint towards the exterior. It is explained, as well as many appearances of the same kind, by the refraction of the light of the body through ice crystals; in fact, the crystals of ice are hexagonal prisms, of which the faces are in pairs inclined at 60°. These crystals, disseminated in the air, and pointing in all directions, refract the light, but the refracted rays cannot exceed the slant of 22° which the *minimum deviation* discovered by Sir Isaac Newton imposes on them; the limit of the refracted rays is, therefore, a cone of 22° round the line which joins the eye with the sun or moon.

[*Experiment imitating the Halo.*—Crystals are produced in a transparent medium, consisting of a mixture of appropriate liquids; in this way the mixture of hot and damp layers of the atmosphere is reproduced precisely, with the cold layers, which form the crystals of ice.

For this purpose a saturated aqueous solution of potash alum is placed in a glass cell, and through this cell a stream of light is made to pass, projecting the image of a circular opening representing the sun on a dark sky. Then a quarter of the total volume of rectified alcohol is added; the alum, insoluble in alcoholised water, is precipitated in very small crystals which float about in the liquid. The image of the sun is at first indistinct, as in a mist, but soon a brilliant circle, with delicate rainbow tints, appears, and represents exactly the appearance of the halo. The experiment is brilliant and instructive.]

This phenomenon is well known by country people; it is a sure sign of rain when it appears on a hot day, even if no other indications predict a metereological disturbance.

Alternation and Inversion of Temperatures.—In neighbouring observatories situated at very different altitudes, such as that of Puy-de-Dôme and Clermont, the existence of hot currents are often noted in the high regions. It is to successive inversions of the same nature that Mr. Amsler, of Schaffhousen, attributes that beautiful phenomenon known in Switzerland as "Alpenglühen," and which consists of a second illumination of the snowy caps of the Alps some minutes after they had become dark by the setting of the sun.

[Projection of a photograph of the summits of the Bernese Oberland, the Jungfrau, the Mönch, the Eiger; the view having been taken from St. Beatenberg, close to the lake of Thun. Picturesque imitation of the phenomenon by a coloured glass and proper diaphragms.]

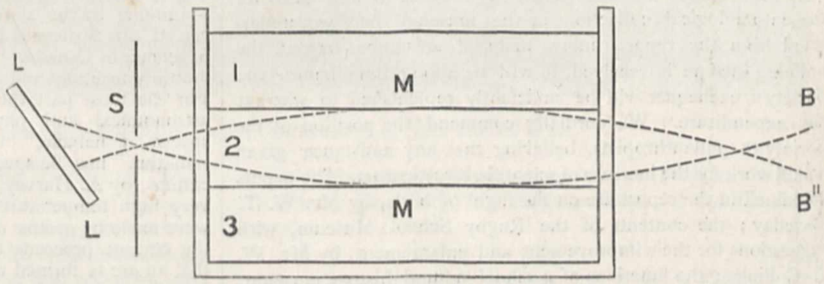

FIG. 2.—(1) Glycerine $\frac{1}{3}$, water $\frac{2}{3}$; (2) glycerine $\frac{2}{3}$, water $\frac{1}{3}$; (3) anhydrous chloride of zinc, $\frac{1}{3}$, water $\frac{2}{3}$.

Mr. Amsler's explanation is founded on the change of the direction of the curvature of the trajectory of the luminous rays depending on whether the air at the bottom of the valleys is warmer or colder than that of the higher regions.

Before the setting of the sun the ground warmed by the solar heat imprints on the trajectory a curve analogous to that of the

[1] Discourse delivered by Prof. Cornu, at the Royal Institution. (Translated by Winifred Lockyer.)

mirage S A M B, that is to say, convex towards the earth (Fig. 1); the sun in going down, at S′, throws the shadow of the summit A on summit B, which should therefore afterwards remain in shadow, as the sun continues to set, and as the last ray is S′ A M′ B′. But if in the interval the air of the valley gets sufficiently cold, the trajectory takes an inverse curve, S″ A M″ B″, and summit B is again illuminated.

[*Experimental Realisation of the Inversion of the Curves of the Luminous Trajectories.*—With a little care it is possible to superpose in a transparent cell of about 20 centimetres thickness three layers of liquid, of which the composition is given under Fig. 2. A movable mirror, L L, throws a stream of light through the opening, S, of a diaphragm. This beam of light, sent under different inclinations, is reflected either by the inferior layer of chloride of zinc (dense, but less refracting), or by the layer of diluted glycerine (lighter and also less refracting than the intermediate layer).

A little fluorescene illuminates the trajectory of the streams of light, and renders their curves visible; the Alpenglühen can thus be represented with a few accessory arrangements.]

Scintillation of Stars.—This phenomenon is also a proof of the alternation of the temperature and of the movement of the layers of air in the high regions. Spectrum analysis shows that the scintillation is produced by a disappearance following a regular order (in accordance with the variation of the zenith distance of the star) of the successive colours of the spectrum.

[*Imitation of the Phenomenon.*—It is obtained by a very brilliant experiment, which consists in throwing the image of a luminous opening, O, with the help of a lens, L, on a little silvered ball, B, of 3 or 4 centimetres in diameter, resting on black velvet. Thus the aspect of a fixed star is obtained, with remarkable brightness (Fig. 3).

But the luminous opening, O, is made in a card, on which is thrown the spectral image of a slit, F, which is dispersed by a direct vision prism, P.

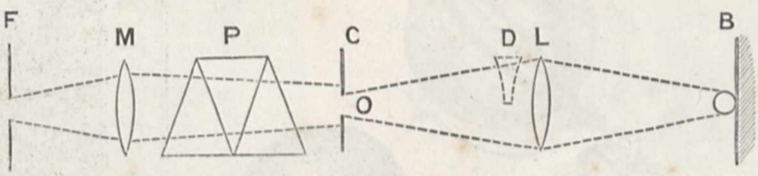

FIG 3.—Arrangement for imitating the phenomenon of the scintillation of stars.

In truth, the card, C O, is not in the focus of the spectrum, which focus is formed further off, in the plane of the lens L. The result is that the rainbow image of the slit on the card has a white part in its centre; it is there that the opening, O, is placed. Also the light thrown on the ball, B, is entirely colourless. But the beam of light, on coming out of the opening, expands into spectrum on the lens of projection L, which recomposes it in B, as in a celebrated Newtonian experiment.

Then by placing a screen with large meshes before the lens L, certain radiations are taken away, and the star, B, appears coloured.

A *divergent half-lens*, D, with same focus as L, cancels its effect, and the spectrum of the star, with the artificial bands created by the screen, appears on a white screen by the side of the ball. This is the imitation of the spectrum analysis of the scintillation of stars.]

It is seen by these few examples that the study of the *optical phenomena* of the atmosphere, aided by physical analysis and *synthesis*, can, and must, teach much about the calorific phenomena of the regions beyond our reach.

Dynamic Phenomena of the Atmosphere.—The phenomena studied up till now are due to conditions of almost perfect equilibrium in the atmospheric layers; they might be called *static*. But the calorific action of the sun, combined with the cooling action of radiation in space, can produce phenomena of movement representing every degree of intensity, from the feeblest to the most violent: we call these phenomena *dynamic*. They make themselves apparent in very different ways.

(1) Under the form of *mechanical energy*: winds, whirlwinds, cyclones, water-spouts, &c. (2) Under the form of *calorific energy*, which makes itself felt by the formation of clouds, rain, hail corresponding to different changes of state of water, the element of the atmosphere which is continually varying. (3) Under the form of *electric energy*: lightning, thunder, &c.

In fact, it is the transformation of the solar energy into mechanical energy which is the fundamental phenomenon; it brings all others with it. It is the only transformation which, for shortness, I shall deal with here.

The simplest mechanical phenomenon which is produced in the atmosphere is the wind. The origin of the wind is the difference of pressure between two points more or less distant; since the time of Pascal, it is known that the pressure of air is measured by the barometer. It might be thought, according to this property, that the direction of the wind is always determined by the indications of this instrument; that is to say, that the wind must go from the point where the barometric pressure is strongest to the point where the barometric pressure is feeblest.

Well, this is hardly ever the case; the real direction of the wind is always oblique to this theoretical direction. This fact has only been known a very few years; it is the general meteorological maps, suggested by Le Verrier about thirty years ago, and so universally known at the present day, which have put this fact beyond doubt.

The direction of the wind seems to *turn round* the point of the map where the *minimum* pressure is to be found, in the *opposite direction* to the hands of a watch; or, rather, in a *direct sense* round the point of maximum pressure. Such is the direction of the phenomenon in the *northern hemisphere*; it is contrary in the southern. In fact, the most ordinary movement of the atmosphere is a *gyratory* movement, which is called a cyclone.

The whirling movement of the air has been observed for a long time; we often see it produced around us. The dust, the dead leaves are lifted by the wind in a whirlwind resembling eddies in rivers. Sailors know of *cyclones* and *water-spouts*, and fear their dangerous effects. On the American continent there are terrible hurricanes called *tornados*. These gyratory movements seem only to belong to great stormy perturbations; but the more the study of the atmosphere is followed in detail, the more it is seen that this kind of disturbance is met with in all manifestations of displaced air. It is therefore concluded that the gyratory movement is to some extent the *normal* condition of agitated air; it would hardly be possible to employ force on a gaseous mass without developing more or less rapid rotations, which tend to acquire for themselves a permanent condition.

Experimental Proofs.—Every time a rapid jet of gas is produced, one or more cyclonic movements are formed at the side of the jet. If the projected column is of a cylinder shape, the cyclonic movement will take the form of a ring; for example, the rings of smoke which are observed after the explosion of cannons, guns, &c.

[Repetition of the well-known experiment of smoke-rings, produced by striking the canvased end of a box filled with vapour of hydrochlorate of ammonia, with a circular opening on the opposite side. The smoke-rings are rendered visible by throwing them in the line of a beam of electric light.]

Multiple Origin of the Gyratory Movements of the Atmosphere.—Nearly all the general causes which act on the movement of the atmosphere are gyratory influences; when once the movement is set going, it continues of itself, and sometimes increases in amount; in the first place, the movement of the rotation of the earth must be cited, which always brings with it a small component of rotation for a displacement of a gaseous mass in *latitude* or *altitude*; in the second place, and as decisive cause, the solar heat, which warms the air near the surface, or the clouds. As the ascending tendency of the heated gas cannot be equal over the whole surface exposed to the rays of the sun (as much because of the nature of the ground as because of its inequalities), the equilibrium is upset in certain parts, and gaseous columns ascend. This is, therefore, the same case as the jets, quoted above, and consequently under favourable circumstances for gyrations round horizontal axes. When once the gyration is established, the causes which have produced it keep it up and augment it.

The existence of whirlwinds with horizontal axes in hail-storms, particularly in that of May 20, 1893, at Pittsburg, has been observed by an American meteorologist, Mr. Frank W. Very, and has furnished him with a very ingenious explanation of the formation of hail. Indeed, such a whirlwind (if it has sufficient dimensions) takes the hot and damp air of the surface of the ground to high and cold regions; the vapour condenses, freezes, and crystals of ice are brought into the gyratory movement; they ascend and descend alternately, following the spirals of the whirlwind, and increase at every passage in the inferior regions, which are charged with humidity. This explanation accounts for all the peculiarities which are observed in a fall of hail: zoned structure, very low temperature; special sound before the fall; electric manifestations which accompany them; for a whirlwind of hail is a veritable influence electric machine, a sort of *replenisher*.

Artificial Reproduction of Natural Gyratory Phenomena.—The phenomena produced by the rapid rotation of the air are altogether unexpected in consequence of the singularity of forces put in play. The ordinary laws of mechanics, to which daily experience has accustomed us, seem entirely different to those which the cyclonic movements seem to obey; and this must not astonish us. We have reduced mechanics to its simplest elements; the material point, the constant force, the rectilinear movement: thanks to these simplifications, we have been able to understand the movement of spherical projectiles, that of a pendulum, the rotation of a fly-wheel, &c. But as soon as the solid body becomes complex as to its form, when the movement which it may take has at the same time a translation and a rotation, our imagination represents it badly; if to this complication of form we add the resistance of the surrounding medium, then we have no idea of the probable resulting effect; for example, the *boomerang*. As to the movements of fluids, they are so difficult for us to foresee, that we receive fresh surprises every time we move a vessel of water; as soon as the mass of water is at all considerable, the tumultuous movements, which we unwillingly cause, always produce some awkwardness.

We understand then how impossible it is for us to anticipate the atmospheric movements, of which the mass is so immense, for each cubic metre weighs 1,300 grs.; if the energy expended in setting in movement such masses is considerable, inversely the stability of the system is enormous, since we have to wait for the dissipation of this energy by the passive resistances, almost always reduced to friction on the earth's surface.

We will, therefore, not endeavour to analyse the forces put in play in the gyratory movements of the air. I will limit myself to repeating before you some of the beautiful experiments of M. Ch. Weyher, who has been good enough to come himself to help me arrange the apparatus now before you.

Here is a sphere composed of ten circular paddles, put in rapid motion round axis A B (Fig. 4); the air caught in the rotation produces a general whirlwind movement, symmetric in relation to the plane of the equator. On all sides the air is sucked in by the revolving sphere, which may be seen by the effect on smoke or pieces of paper brought near it. This air is expelled from the equatorial circumference, and only in the almost mathematical plane of this circumference; in fact, look at these pieces of paper which keep themselves concentrically to the equator, following an arrangement which reminds us of Saturn's ring. The tension of the paper and its vibrations show that it is the repulsion of the equatorial outflow which maintains them.

It might be concluded from this, that the revolving sphere could only produce equatorial repulsions; but the complexity of the turbulent streams baffles the most evident anticipations. If a light balloon be approached a little distance from the sphere, it is immediately attracted, and begins to revolve rapidly round the sphere in the equatorial plane; if a second or third be let loose in the same way, they will follow it at varied velocity, and represent satellites; the planetary configuration is complete.

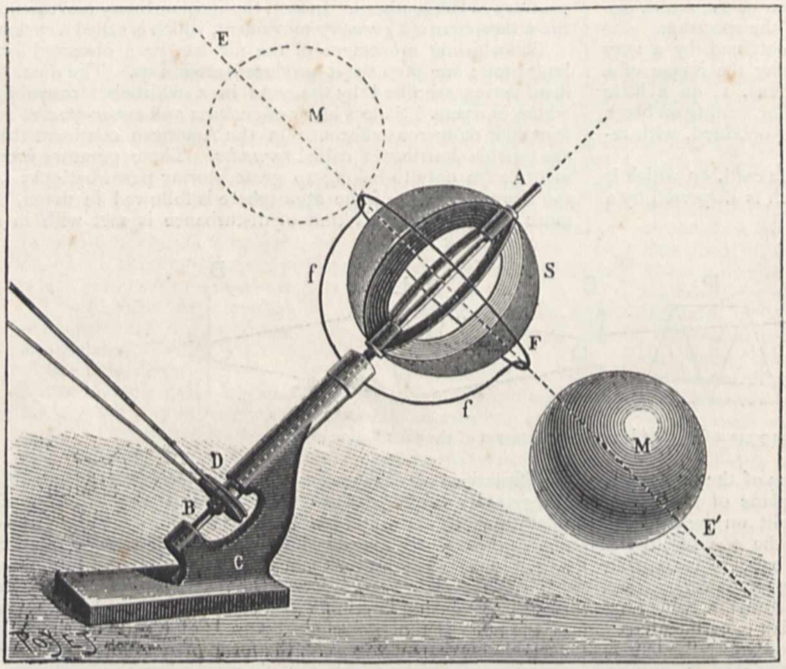

Fig. 4.—Artificial reproduction of the gyratory natural phenomena.

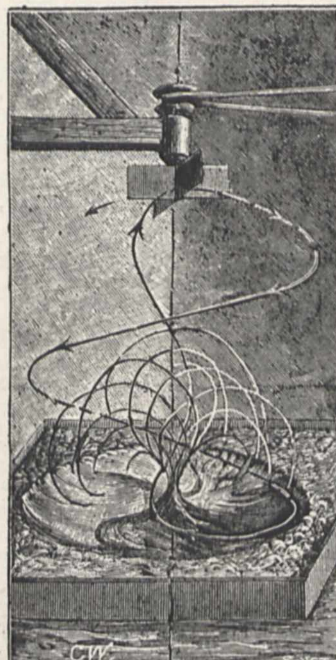
Fig. 5.

This paradox of a repulsion transformed into attraction by a change of form of the presented body, is easily solved by considering the resultant of aspiring and repelling actions on the surface of the moving body. On the greatest angular space round the revolving sphere it is the whirlwind attraction which dominates. This is easily proved by placing underneath this sphere a basin full of hot water; if the atmosphere of the room is quiet, little by little the vapour will be seen to collect in a whirl from the surface of the water to the revolving sphere (Fig. 5). This is the imitation of a water-spout. The importance of this phenomenon has led M. Weyher to reproduce it in a more striking way, and by bringing into play a much more considerable quantity of mechanical energies, thus recalling better those which constitute this natural phenomenon.

The excitement of the gyratory movement (which, in nature, has its source in higher regions of the atmosphere) is produced by a small mill, placed three metres above a reservoir of water four metres in diameter (Fig. 6). When the small mill is made to revolve (400 to 500 revolutions a minute), the aerial whirlwind sucks up little by little the surface of the water, which is seen to be agitated and to be forming *centripetal* spirals, and producing a liquid cone several centimetres in height. Above this cone a great number of little drops accumulate, which fall back in spirals. This attraction, *at a distance*, is even more striking if the water is slightly heated; the vapour then forms a *hollow* tube, of which the hollow part is distinguished by its dark colour and its geometrical regularity; it shoots forth from the water towards the small mill, causing light objects, such as bits of straw, which are floating on the liquid, to be thrown up.

Such is the experiment which in 1887 was made in the open air at the great works of the Weyher and Richmond Company. With the reduced apparatus, now placed before you (Fig. 6), we can repeat it in conditions quite as convincing. The small mill is placed at the top of the case two metres high, closed on one side by a glass; the water, slightly warmed and containing a little soap, is placed at the bottom of the case in a basin. I set the small mill going; you see the agitation at once, the soap-bubbles precipitate themselves at the foot of the column of vapour. Soon the column takes the form already described, and represents exactly the appearance of a real water-spout; at the foot is the *buisson*—that is to say, the collection of bubbles and little drops; at the top, the expanded hollow tube of vapour.

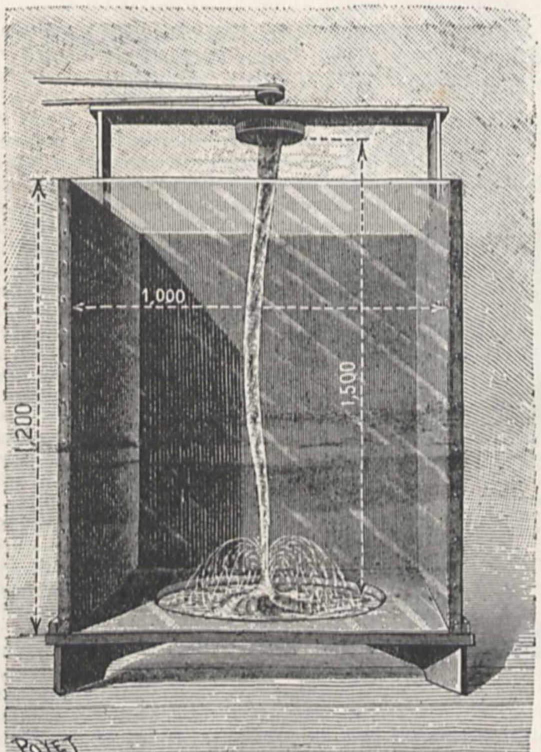

FIG. 6.—Artificial reproduction of a water-spout.

A light balloon placed at the surface of the water is first carried to the centre, and rendered captive at its foot; by quickening the rotation (which increases the power of the whirlwind) the balloon is raised by the water-spout, and sometimes follows the spiral the whole of its height.

The helicoidal movement of this light balloon, as well as the aspect of the nebulous spiral, shows well the constitution of the water-spout; one sees the superposed rolls of helicoidal currents, some ascending, others descending (Fig. 7); it is a perpetual going and coming between the mill and the surface of the water. As all the currents turn in the same direction if the ascending ones *screw* to the *right*, the descending ones *screw* to the *left*. It is the absence of having recognised this double movement of ascent and descent which is at the bottom of the misunderstanding between the partisans of ascending water-spouts and those who maintain that they are only descending phenomena.

The ascending movement of the light balloons caught up by the water-spout, shows well the ascending velocities; it is more difficult to put in evidence the descending region, declared in some theories to be the only existing one, because it occupies in the reduced experiment a very small space; it is confined to the interior of the nebulous sheath, of which the hollow centre is distinguished by its dark colour. I will, however, show it to you with the help of a very simple artifice. Take a body emitting smoke to the top of the water-spout; we see this aspirated smoke at once reach the interior of the sheath, roll itself into a slender cone, and descend to the surface of the water. This is exactly what is seen in nature when, in a water-spout, the clouds descend in the form of a stream which grafts itself in the middle of the *buisson* formed by the water at the surface of the boiling sea. This spiral is, so to speak, the harmless part of the water-spout; the terrible part is invisible; it is formed by the mass of air which rages round the spiral. In the experiment before us it is contrary. The raging mass is visible owing to the smoke which is supplied; the interior of the spiral remains dark; it is by the introduction of the smoke that the existence and form are recognised.

There still remains to show you that with a similar arrangement a cyclone can be produced with all its characteristics—variation of pressure at its passage, barometric minimum, central

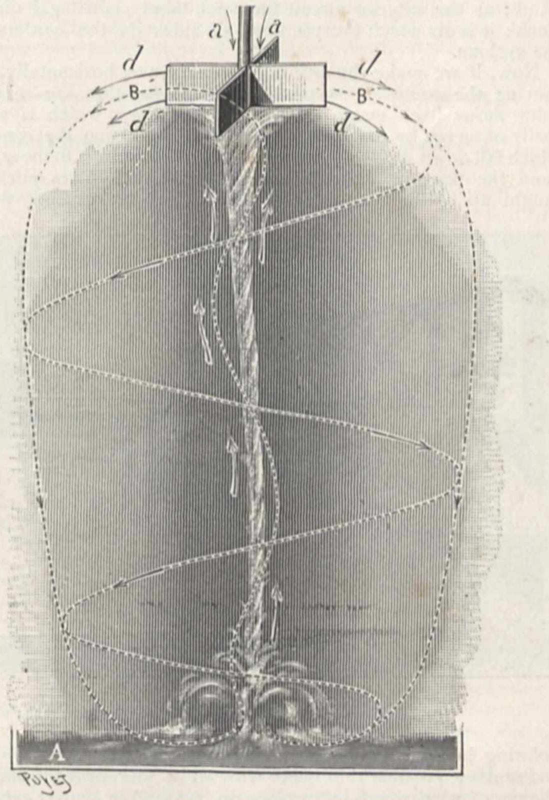

FIG. 7.—Double direction of liquid currents in a water-spout.

calm, brisk rising of wind, centre of the storm, &c.—which has also been attained by M. Weyher.

The following remarks have been subsequently added to the lecture at the Royal Institution:—

We will conclude by describing with some detail that experiment which reproduces so accurately all cyclonic phenomena. In reality a cyclone is nothing else than an immense aërial whirlwind; it only differs from a water-spout by its proportions, and principally with respect to the height and the diameter; in a water-spout the diameter is very small in relation to the height, whereas in the cyclone it is the contrary. But in both cases the general movement is the same; the aërial currents descend all around, to remount immediately on the interior spirals, with a diameter more or less great, but leaving, as in a water-spout, a central region free, in which the descending movement is equally to be found.

Here is a flat rotating disc, about 1 metre in diameter, mounted on the extremity of a crane 2 metres in radius; by means of this arrangement it is possible to make the rotating disc travel horizontally above a large table in which are fixed a great number of pins, to the head of each of which is attached a bit of wool some centimetres in length, and thus forming many flags, which will show us the directions of the wind in each point traversed by the cyclone. In the centre of the table a hole is pierced communicating underneath with a very sensitive barometer, which will show us the variations of atmospheric pressure at the passage of the meteor (Fig. 8).

We set the rotating disc in rotation after having placed it above one of the extremities of the table; you see at once all the flags situated underneath indicate the directions of the wind. Those which form the centre of the whirlwind remain flat and rest inert on the table, their extremities directed one towards the other. They represent wonderfully well the central calm.

The flags surrounding the central calm form a circumference; they imply a wind forcing them all in a direction slightly centripetal, and ascending. In the following ranges the pieces of wool place themselves again along a circumference, but scarcely showing the centripetal direction, and not at all the ascending one; then the more distant the flags are from the centre, the more they inflect towards the table, and indicate the descending wind; at the exterior circuit the wool takes centrifugal directions; it is air which escapes from all sides on the borders of the cyclone.

Now, if we make the artificial cyclone travel horizontally, by moving the crane on its pivot, you will see that the central calm shows itself every instant at a new place, which is very easily observed by the aspect of the flags occupying the centre, which fall down suddenly and rest inert on the table. On the other hand the flags immediately adjacent raise themselves quickly, caught up by the tempest, and those which but recently were pointing in one direction, turn all at once in the opposite one, and make it possible to observe with all its sharpness the abrupt change of wind which takes place on leaving the central calm.

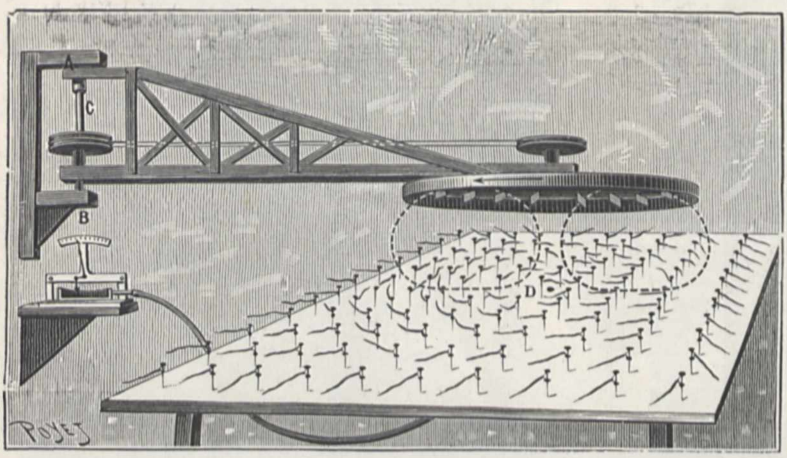

Fig. 8.—Artificial reproduction of cyclonic phenomena.

By making the cyclone travel with sufficient quickness, the flags permit us to take note of the dangerous and manageable sides of a cyclone, according as one looks at the semicircle in which the wind turns in the same direction as the movement of translation, or in the opposite one.

The variations of pressure are indicated by the passage of the cyclone above the hole made in the table, and communicating with the barometer; you see the needle falling little by little, indicating the minimum precisely at the moment when the centre of the cyclone passes above the hole, then rising slowly.

A thermometer sufficiently sensitive, placed in the centre of the cyclone, allows us to observe a rise of temperature.

In great cyclones, a ship on reaching the centre not only finds a general calm, but the sun or stars may be seen to shine through a great opening in the clouds; it is the eye of the storm.

In order to explain this fact, it suffices to remark that a cyclone is only in fact a water-spout of enormous diameter, in the immense sheath of which rages the storm of a descending movement, dragging down the hurricane and the clouds from the high regions to the level of the sea; but, as in the water-spout, the central nucleus remains free, and allows a clear sky to be seen.

The realisation of this eye of the storm succeeds equally well with steam or smoke by taking necessary precautions with the experiment.

Finally, as the centre of the cyclone is free of water vapour (at least in the visible form), whilst in the enveloping sheath storm and darkness reign, is it not evident that a hygrometer placed in this cloudy sheath will show a degree of moisture above that of the central nucleus?

To sum up—it may be seen that, however small the scale of the experiments in comparison to that which passes in nature, nevertheless these experiments reproduce with fidelity and with all the particularities of the great natural meteorological phenomenon.

The experiments which you have just seen will, I hope, suffice to show you how complete the experimental syntheses are, and how they represent the natural phenomena in the smallest details.

I will conclude by making the simple remark that meteorology gains in extent and certainly when we treat it as an experimental science.

A. Cornu.

IMMUNISATION AGAINST SERPENTS' VENOM, AND THE TREATMENT OF SNAKE-BITE WITH ANTIVENENE.[1]

II.

The experiments now to be described were made with antivenene derived from a horse which had last received a dose of cobra venom estimated to be twenty times the minimum-lethal. On some previous occasions I have stated the results of observations on the antidotal value of the blood-serum of rabbits which had last received thirty and fifty times the minimum-lethal. The antivenene obtained from cats and white rats has also been examined. The special interest, however, is attached to antivenene derived from the horse, that it is more likely than any others to be used in the treatment of snake-bite in man.

The experiments were so planned as to obtain in different conditions of administration as exact a definition as possible of the antidotal power of the antivenene. In the meantime, four series of experiments have been undertaken on rabbits. In one series the venom was mixed outside of the body with the antivenene, and immediately thereafter the mixture was injected under the skin of the animal; in the second series the venom and antivenene were almost simultaneously injected into opposite sides of the body; in the third series the antivenene was injected some considerable time before the venom; and in the fourth series the venom was first injected, and thirty minutes afterwards the antivenene.

In the experiments of the *first series*, the doses of cobra venom administered were the minimum-lethal, one-and-a-half the minimum-lethal, twice, thrice, four times, five times, eight times, and ten times the minimum-lethal. In the case of each dose of venom, experiments were made with different quantities of antivenene, until the smallest quantity required to prevent death was discovered. In order to render it certain, in this and in the other series, that a lethal dose had been administered in the experiments with the so-called minimum-lethal, the minimum-lethal indicated by previous experiments was not used, but instead of it a slightly larger dose (·00025 instead of ·00024 gramme per kilogramme).

When this certainly lethal dose, capable of producing death in five or six hours, was mixed with the antivenene, and the mixture injected two minutes afterwards, under the skin, it was found that so small quantities were sufficient to prevent death as ·001 cc., ·0008 cc., ·0005 cc., and ·0004 cc. (1/1000, 1/1500, 1/2000, and 1/2500 of a cc.) for each kilogramme of the weight of animal; with ·0003 cc. (1/3333) per kilogramme, however, the animal died. The antivenene was therefore found to be so

[1] Continued from page 572.

powerful as an antidote, in the conditions of these experiments, that even the 1/2500 part of a cubic centimetre, equivalent to about the one-hundred-and-fiftieth part of a minim, acted as an efficient antidote, while even with the one-two-thousandth part of a cubic centimetre not only was death prevented, but there was almost no symptom of poisoning produced. In the experiments of this series with one-and-a-half the minimum-lethal dose, recovery occurred when the doses of antivenene were ·32 cc., ·3 cc., ·28 cc., ·25 cc., and ·24 cc. per kilogramme; but ·23 cc. and ·2 cc. failed to prevent death. In the experiments with twice the minimum-lethal dose, recovery occurred when the doses of antivenene were ·5 cc., ·4 cc., and ·35 cc.; but ·3 cc. and ·2 cc. failed to prevent death. In the experiments with thrice the minimum-lethal dose, a dose capable of producing death in less than two hours, recovery occurred when the doses of antivenene were ·7 cc. and ·65 cc.; but death occurred with ·6 cc., ·55 cc., and 5 cc. With four times the minimum-lethal dose, recovery occurred with 1·5 cc., 1·3 cc., and 1·2 cc., and death with 1 cc. With five times the minimum-lethal dose, recovery occurred with 2·5 cc., 2·2 cc., 2 cc, 1·8 cc., and 1·5 cc.; but death with 1·3 cc. With eight times the minimum-lethal dose, recovery occurred with 2·6 cc. and 2·5 cc.; but death with 2·4 cc., 2·3 cc., and 2 cc. And even the enormous dose of ten times the minimum-lethal failed to produce death, or any important symptoms, when it had previously been mixed with 3·5 cc. and 3·4 cc. of antivenene for each kilogramme of animal; and it only succeeded in producing death, although not until the lapse of several hours, when the doses of antivenene were 3·3 cc., 3·2 cc., 3 cc., and 2·5 cc. per kilogramme.

These results show a remarkable, an almost directly proportional, accordance in the increment required in the dose of antivenene for each increment in the dose of venom. In the diagram the comparatively straight direction of the oblique line separating the fatal from the non-fatal experiments is noteworthy, considering that the conditions of the experiments, in regard both to the animals and the substances used, could never be absolutely the same. Indeed, from twice the minimum-lethal dose of venom upwards, the addition of little more than ·3 cc. per kilogramme represents the addition in the quantity of antivenene required for each addition of a minimum-lethal dose of venom. Apparently the antivenene is able in this proportion to prevent death from almost any lethal dose of venom, however large it may be.

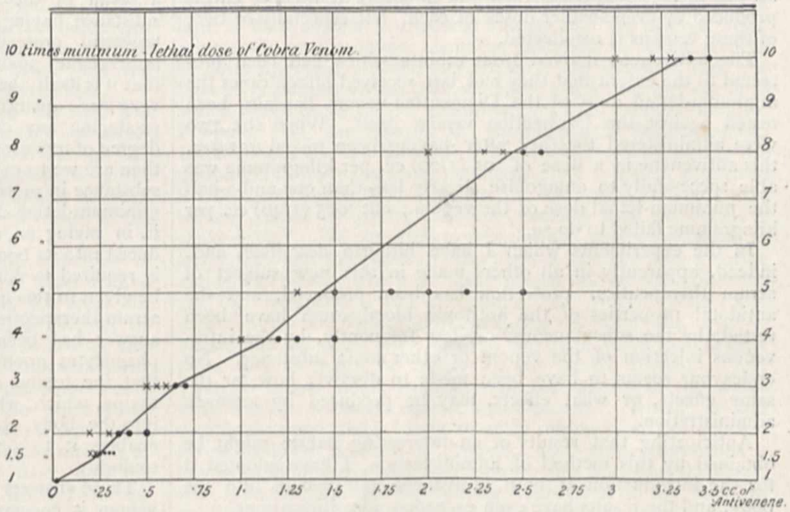

FIG. 2.

These results are in marked contrast with those that occur when an antidote acts because of its physiological properties, and they alone suggest that the antidotism is rather the effect of a chemical than of a physiological reaction. The indications obtained with doses of twice the minimum-lethal and upwards cannot, however, be carried down to the minimum-lethal dose. The quantity of antivenene required to prevent death from this dose is much less than might have been anticipated when the results of experiments with larger doses are considered. Thus, it appears that while ·35 cc. of antivenene per kilogramme is required to prevent death from twice the minimum-lethal of venom, the minute quantity of the 1/2500th of a cc., or nearly 1000 times less (·0004 as compared with ·35 cc.), is sufficient to prevent death from a little more than the minimum-lethal dose of venom. It is apparent that this minute quantity of antivenene does not render inert the whole of the minimum-lethal dose. All that is required in order that the minimum-lethal dose should not produce death being that only a minute portion of it should be rendered inert; for, if this dose be the actual mininum-lethal, the rendering inert of any portion of it, however minute, will prevent the remainder from causing death.

In the *second series*, experiments with the antivenene of the horse have been completed only with one-and-a-half the minimum-lethal dose of venom. When this dose was injected into the subcutaneous tissues of one side of the body, and, immediately thereafter, a dose of antivenene into the subcutaneous tissues of the opposite side, it was found that antivenene in doses of 3 cc. and 3·3 cc. per kilogramme failed to prevent death, but that 3·5 cc. and 3·6 cc. per kilogramme were able to do so.

In the *third series*, experiments have been made with the minimum-lethal, one-and-a-half the minimum-lethal and twice the minimum-lethal dose of cobra venom. With the first of these doses, recovery occurred with ·5 cc., ·45 cc., and ·42 cc.; but death with ·4 cc., ·3 cc., and ·25 cc. of antivenene, administered thirty minutes before the venom. With one-and-a-half the minimum-lethal of venom, 2·9 cc. and 2·7 cc. of antivenene were able to prevent death; while 2·6 cc., 2·5 cc., 2·3 cc., and 2 cc. each failed in doing so. With twice the minimum-lethal dose of venom, recovery occurred when the doses of antivenene were 5 cc., 4·5 cc., and 4 cc.; but 3·9 cc., 3 8 cc., 3·5 cc., 2·5 cc., and 2 cc. were insufficient to prevent death.

In the *fourth series*, where the results give the truest indications of the antidotal value of antivenene in the actual treatment of snake-poisoning, it was found that recovery occurred in the experiments in which ·8 cc., ·7 cc., and ·65 cc. per kilogramme of antivenene was injected thirty minutes after an assuredly minimum-lethal dose (·00025 per kilo.) of venom; but that the antivenene was insufficient in quantity to prevent death when ·6 cc. or any smaller quantity was administered. In this series, further, it was found that 3·4 cc. and 3·2 cc. per kilogramme of antivenene were sufficient doses to prevent death after one-and-a-half the minimum-lethal dose of venom, but that 3 cc., 2·8 cc., and 2·5 cc. per kilogramme were insufficient. In a corresponding series of experiments made with the antivenene derived from rabbits which had last received thirty and fifty times the minimum-lethal dose of cobra venom, it was found that 5 cc. per kilogramme of this antivenene was the smallest dose by which death could be prevented in an animal which had received twice the minimum-lethal dose of venom thirty minutes previously.

Attention is conspicuously drawn by these facts to the remarkable difference in the dose of antivenene which is required to prevent death when it is mixed with the venom before administration, as contrasted with the doses required when the two substances have not previously been mixed together. Restricting attention to the experiments in each series in which the dose of venom was the same—to the experiments with one-and-a-half the minimum-lethal dose, for instance—it appears that in order to prevent death, when this dose was mixed with antivenene before administration, only ·24 cc. of antivenene is required; whereas when both substances were injected simultaneously, but under the skin at different parts of the body, the required dose of antivenene is 3·5 cc.; when the antivenene was injected thirty minutes before the venom, it was 2·7 cc.; and when the venom was injected thirty minutes before the antivenene, it was 3·2 cc. per kilogramme.

It is impossible to consider the great difference between the dose of antivenene required when the two substances, though in each case simultaneously administered, are, in the one case, mixed together before injection, and in the other not so mixed, without again having the suggestion originated that the antidotism is the result of chemical and not of physiological reactions.

This suggestion receives a further support from the fact, observed in several experiments, that the longer before their administration the two substances were allowed to remain together after they had been mixed, the greater is the antidotal efficiency of the antivenene. Thus, while 1·3 cc. per kilogramme of antivenene, mixed with five times the minimum-lethal dose of venom, was followed by death when the two had been mixed together five and also ten minutes before administration, this mixture was, on the other hand, followed by recovery when the interval before the administration was extended to twenty minutes. In order to obtain uniform and comparable results in the first series of experiments, it was therefore found necessary to adhere, in all the experiments made with the larger doses of venom, to a time limitation of not more than ten minutes before the mixed substances were injected.

I have also administered cobra-antivenene thirty minutes after a dose one-twelfth larger than the minimum-lethal of the venoms, respectively, of the *Sepedon hæmachates*, the *Crotalus horridus*, and the Diamentina serpent; and the animals experimented on have recovered when the dose of cobra-antivenene was not smaller than 1·5 cc. per kilogramme. This successful result is all the more remarkable when the intensely destructive effects produced by even smaller doses of each, but especially of two, of these venoms is recollected.

The antivenene derived from rabbits which had been protected to the extent that they had last received fifteen times the minimum-lethal dose of the Diamentina venom has also been tested against the Diamentina venom itself. When the two were administered together, after having been mixed *in vitro*, this antivenene in a dose of ·05 (1/20) cc. per kilogramme was able successfully to antagonise slightly less than one-and-a-half the minimum-lethal dose of the venom; but ·025 (1/40) cc. per kilogramme failed to do so.

In the experiments which I have hitherto described, and, indeed, apparently in all others made in this new subject of serum therapeutics, protection has been produced, and the antidotal properties of the antitoxic blood-serum have been tested, by the subcutaneous, or, less frequently, by the intravenous injection of the venom or other toxic substance. No endeavour seems to have been made to discover how far the same effects, or what effects, may be produced by stomach administration.

Anticipating that results of an interesting nature might be obtained by this method of administration, I have adopted it for the introduction of both antivenene and venom into the body, and the results have even exceeded my anticipations.

The plan followed was the simple one of mixing the substances, previously dissolved in water, with a small quantity of milk, and allowing white rats, which had not received any food for several hours previously, to drink this milk. In the meantime, I will briefly describe only those experiments in which antivenene was thus administered, reserving, for a few minutes, a description of the results that were obtained when the venom itself was used.

The first experiments were made with the object of determining if, by repeating the process followed in the production of immunity, with the exceptions that the administrations were by the stomach and that antivenene was substituted for venom, an animal could be protected against the poisonous effects of venom. With this object, a white rat received on alternate days during several weeks, doses of antivenene, which were gradually increased from 1 to 10 cc. per kilogramme, and then, by subcutaneous injection, one-and-a-half the minimum-lethal doses of cobra venom; with the result that death was not produced. Other white rats received 10 cc. per kilogramme on each of four days, and on the fifth day 15 cc. per kilogramme of antivenene, and still recovery took place when one-and-a-half and one-and-three-quarters the minimum-lethal dose of venom was injected under the skin. To other white rats, 10 cc. and 15 cc. of antivenene were given by the stomach, on two successive days, and on the second day, one-and-a-half the minimum-lethal dose of venom, and the result also was that death was prevented. It was thus suggested that a single administration of antivenene might be as efficacious as a succession of administrations; and accordingly, the antidotal efficiency of single doses of 7 and of 10 cc. per kilogramme was tested, in some instances three hours, in others two days, and in others three days before one-and-a-half the minimum-lethal dose of venom was subcutaneously injected; and in all cases the animals recovered. When, however, 5 cc. per kilogramme of antivenene was thus administered three hours before, and 10 cc. per kilogramme three days before, one-and-a half the minimum-lethal dose of venom, the animals died.

The experiments have not as yet been carried further, but I hope to continue them so that the limits of the antidotal power of the antivenene, and the duration of the protection after single doses of antivenene, may be defined. Enough has, however, been done to prove that the stomach administration of antivenene, equally with its subcutaneous administration, confers protection against lethal doses of serpents' venom, and to justify the use of antivenene by the former and more convenient method for the purpose of securing protection for, at least, a period of several days after a single administration of the protecting antidote.

The facts hitherto narrated are sufficient to establish that the protection acquired by animals as a result of the administration of venom is not chiefly, or even to any important degree, caused by the venom having produced a tolerance by accustoming the body, as it has been expressed, to the presence of the venom—although a certain degree of this protection may possibly be due to such accustoming—but rather to the presence in the body, as a result of the introduction into it of venom, of a definite substance having antivenomous qualities. Notwithstanding the powerful protective and antidotal action of this substance (antivenene) against serpents' venom, it is instructive to find that it is itself almost devoid of any physiological action, for even very large quantities may be injected under the skin without producing any other physiological reaction than a moderate degree of irritation in the neighbourhood of the injection. How then are we to explain the operation of this physiologically inert substance in protecting an animal against even fifty times the minimum-lethal dose of venom, or by a single administration of it, in saving an animal from death after there has been introduced into its body more than twice the quantity of venom that is required to kill it? When an answer has been attempted to be given to this question in discussions in the wider field of the serum therapeutics which deals with the toxines of diseases, the answer has been found either in the destructive power of phagocytes upon microbes and their toxines, or in the theory that the toxine elaborates from the blood the antidotal antitoxine, which, whether thus originated or separately introduced into the body, confers upon the body a resisting power which enables it to oppose successfully the injurious action of the toxines.

These answers cannot solve the problem in so far as snake venom is concerned. Phagocytosis cannot, of course, operate *in vitro* in solutions which are free from organised structures. Even when solutions of venom and antivenene, mixed together *in vitro*, have been inserted into the body, it is incredible that the increase in the quantity of antivenene by the 1/500th part of a cubic centimetre could cause such an increased proliferation of leucocytes as to prevent a lethal dose of venom from producing death, whereas a dose only the 1/500th part of a cubic centimetre smaller would be unable to do so. Further, there is no observable increase of leucocytes when much more than these infinitesimal quantities of antivenene have been administered to an animal.

In view of many of the facts that have to-night been stated, the "resistance of tissues" theory is also untenable. It is opposed, for instance, by the fact that so great a quantity of antivenene as ·42 cc., or nearly ½ of a cubic centimetre per kilogramme is required to prevent death when given thirty minutes before a lethal dose of venom, whereas, for the same dose of venom, only ·0004 cc. or the 1/2500th part of a cubic centimetre, or nearly the 1/000th part of the former dose is sufficient, when it is mixed with the venom before administration, and in circumstances, therefore, which are much less favourable for the production by the antivenene of this supposed increase in the resistance of the tissues.

As I have already pointed out, however, a chemical theory, implying a reaction between antivenene and venom, which results in a neutralisation of the toxic activities of the venom, is entirely compatible with the observed facts.

The experiments which I have described to-night indicate that, with some limitations in the largest quantities, the greater the quantity of venom that has been introduced into the body in the process of producing protection, the greater is the antivenomous power of the blood-serum, and therefore the larger is the production of the antivenene. While not an actual proof, this circumstance is at the same time in harmony with the supposition that the antivenene may actually be a constituent of the venom itself. The difficulties encountered in the separation by chemical methods of the several constituents of venom are so great, that it is not probable that the only proof or disproof of this supposition will soon be obtained by chemical analysis. Some physiological experiments which I have made seem, however, to go a long way in supplying the demonstration, which in the meantime has not been obtained from chemistry.

With the object of determining, in the first place, if the still disputed statement is correct that serpents' venom is inert, or nearly so, when introduced into the stomach of an animal, cobra venom was administered, in a series of gradually increasing doses, to a cat, until finally it had received a single dose eighty times larger than the minimum-lethal; and to each of six white rats, single doses corresponding to 10, 20, 40, 300, 600, and 1000 times the minimum-lethal, if given by subcutaneous injection. Although no poisonous symptoms were produced in the animals by even the largest of these enormous quantities, it was found that the cat had so far been protected, that it could afterwards receive, by subcutaneous injection, one-and-a-half the minimum-lethal dose of cobra venom, without any other injury than some localised irritation at the seat of injection; and that the white rat, into whose stomach 1000 times the minimum-lethal dose had been introduced by one administration, survived perfectly, when seven days afterwards slightly more than the minimum-lethal dose of venom was injected under the skin.

It was also found that the blood-serum of the cat was definitely antivenomous, and the curious further fact was ascertained that her progeny had acquired protection through the milk supplied by the protected mother, thus supplying a scientific foundation for a half-admitted conviction, expressed by Wendell Holmes throughout his "Romance of Destiny," in regard to the heroine Elsie Venner.

These significant facts have been extended in a number of other experiments on white rats. In one group of experiments, each animal received, by stomach administration, 500 times the minimum-lethal, if given subcutaneously; and, as before, no toxic symptoms were observed. On the day following this administration, three of the animals received subcutaneously one-and-a-half the minimum lethal dose of the same cobra venom, and they all recovered. In one of the other three animals, however, death was caused by this dose, when it was injected only three hours after the stomach administration; in a second, when this dose was injected two days after the stomach administration; and in the third, when nearly twice the minimum-lethal was injected twenty-four hours after the stomach administration.

In a second group of experiments, a dose of cobra venom equivalent to 1000 times the minimum-lethal by subcutaneous injection was introduced into the stomach. On several occasions in which this had been done, an injection under the skin of one-and-a-half the minimum-lethal dose of venom made, in some experiments, two days, and in others three days afterwards, resulted in the recovery of the animals. As was anticipated, this large quantity introduced into the stomach, conferred immunity against only certain lethal doses of venom, and, for each lethal dose capable of being rendered innocuous, only within certain definable intervals of time.

The extraordinary result was thus obtained that serpents' venom introduced into the stomach in large quantity—in a quantity, which if injected under the skin would be sufficient to kill 1000 animals of the same species and weight—while it failed to produce any definite symptoms of poisoning, nevertheless produced complete protection against the lethal effect of doses of venom more than sufficient to kill the animals. There is a probable significance, further, in the general resemblance between the results of these experiments and those already described in which antivenene, and not venom, was introduced into the stomach. The bearing of these facts is obvious upon discussions relating to the production of immunisation against the toxines of diseases and to the origin of the antidotal qualities of the blood-serum used in their treatment. It is difficult to account for them otherwise than by supposing that the venom while in the stomach had been subjected to a process of analysis, by which the constituents which are poisonous had failed to be absorbed into the blood, or had been destroyed in the stomach or upper part of the alimentary canal, while the constituent or constituents which are antivenomous, or rather antidotal, had passed into the blood, in sufficient quantity to protect the animals against otherwise lethal administrations of venom. I confidently anticipate that this natural process of analysis will, by-and-by, be successfully repeated outside of the body by chemical methods.

It is further to be observed that by stomach administrations a degree of protection was acquired in a few hours against lethal doses, such as cannot be attained until after the lapse of several weeks by the method of injecting under the skin a succession of gradually increasing doses of venom. In circumstances, which are no doubt exceptional, the application of this method may therefore acquire some practical value.

Early this evening, I had occasion to point out that the leading facts connected with immunisation or protection, now being advanced as scientific novelties, had apparently been ascertained and practically applied for centuries by savage and uncultured tribes and sects in various parts of the world. In regard to the results I have last described, also, I discover that I have been anticipated by a long-existing and even now prevailing practice of unlearned savages. I have found in the *Lancet* of 1886, an interesting note by Mr. Alford Bolton, containing the following: "The most deadly snakes here are the puff-adders, the yellow cobra capellas, the horn-snakes, and the night-adders. Whilst frequently hearing of horses and cattle rapidly succumbing to the bites of these snakes, it appeared strange that the natives themselves, who mostly ramble about the Veldt almost naked, seldom or never appeared to suffer any further inconvenience from the bites of poisonous snakes than would be usual from any accident which would cause a local inflammation; and, on close inquiry, I found that the natives in Bushmanland, Namaqualand, Dumaraland, and the Kalakari, are in the habit of extracting the poison-gland from the snake immediately it is killed, squeezing it into their mouths, and drinking the secretion, and that they thereby appear to acquire absolute immunity from the effects of snake-bites." He proceeds to describe the native treatment of snake-bite, and then adds: "Having a month ago seen a native named Snellsteve, who is a snake-poison drinker and collector, put his hand into a box containing two yellow cobras, and several horn- and night-adders, in doing which he was severely bitten, and has never since suffered anything more than a little pain, such as might be caused by any trivial mishap, I feel I can no longer refuse to believe in the efficacy of the snake virus itself as a remedy against snake-poison." Among several communications which I have recently received on the subject, is one from Dr. Knobel, of Pretoria, who writes that when a boy he came into frequent association with a Bushman shepherd, who informed him that he had for years been in the habit of swallowing small quantities of the dried venom-glands of serpents, and he averred that by doing so he obtained protection against serpents' bites, for he had often been bitten without any other ill-effect than that an irritable wound was produced. He stated that the swallowed venom of the cobra produced greater protection than the venoms of less poisonous serpents; and that not only was this benefit produced by the swallowing of venom, but that there was also produced an exciting intoxication, differing from that of Indian hemp in so far that the venom always produced the same degree of intoxication with a definite quantity, however frequently it was taken, while the effects of the Indian hemp were gradually lessened by repetition. Another correspondent, Dr. Laurence, of Cape Colony, writes that a Kaffir boy, "aged about twenty-five years, frequently brings me for sale snakes of all kinds. . . . I have frequently seen this boy take hold of some most deadly snakes, especially the well-known puff-adder, which he will allow to bite him with impunity. Yesterday, I obtained from him what he states as the reason why the poison did not harm him. When a little boy, while walking in the Veldt, a puff-adder fastened on his leg. He shook it off, calling to his father, who a few minutes after killed the puff-adder and removed the poison glands. He then made small paper pellets and dipped them in the poison, and administered one occasionally to the boy, who stated that that cured him. He expressed his willingness to let any snake bite him." Several other letters I have received describe similar events, and also confirm the statement of Dr. Knobel, that serpents' venom produces intoxicating effects in man, evidences of which have been observed in many of the experiments made by me on the lower animals.

The results of the experiments in which the venom was introduced into the stomach, probably also afford an explanation of the protection enjoyed by certain snake-charmers, as well as by other individuals who claim to be protected, whether members of special sects or not; for although inoculation of the venom is apparently sometimes practised by them, and protection is no doubt assisted and maintained by the bites, which with impunity they frequently receive, they are known also to swallow the venom or the dried poison-glands containing it.

These experiments also seem to throw a new light upon the clearly established protection possessed by venomous serpents against their own venom. They suggested the importance of determining if the blood-serum of venomous serpents contains, as does that of artificially protected animals, an actual substance possessing antivenomous properties.

In order to arrive at some definite conclusions on this subject, I last year obtained from India several living specimens of the Hamadryad (*Ophiophagus elaps*), a serpent of greater size and more aggressive disposition than the cobra, and reputed to be as deadly as it. From the blood of several of these serpents a serum was separated, which when dried gave a product having the same physical characters as the antivenene from artificially protected animals. It was tested against cobra venom, both when mixed with rather more than a minimum-lethal dose, and also when injected thirty minutes after this lethal dose of cobra venom. In the former case, ·25 cc. per kilogramme of this natural antivenene prevented death; and, indeed, so perfectly antagonised this certainly lethal dose that no decided symptoms of poisoning were manifested. In the latter case, 5 cc. per kilogramme was found to be a sufficient quantity to prevent death. I hope by-and-by to extend these observations by testing the antidotal power of this serum against the venom of the actual Hamadryads from whose blood it had been separated.

A determination of this kind has, however, been made with the blood-serum and venom of the Australian black snake (*Pseudechis porphyriacus*), a deadly serpent whose bite produces intense destructive changes, not only at the place where it has been inflicted, but also in the blood and in many of the organs of the body. When the blood-serum and the venom of this serpent were mixed together outside of the body, and then injected under the skin of a rabbit, it was found that half a cubic centimetre per kilogramme of the blood-serum was sufficient to prevent death from rather more than the minimum-lethal dose of venom.

Notwithstanding the obliging co-operation of the India Office, I have not yet succeeded in obtaining the blood-serum of the cobra, but it may safely be anticipated that it also will be found to possess antivenomous properties.

It has thus been shown that venomous serpents themselves possess a definite substance in the blood-serum which is capable of protecting them against their own venom, and the venom of other serpents. The results of the experiments made by stomach administration of venom, supply at the same time an explanation of one, at least, of the methods by which this substance is introduced into the blood. This natural antivenene, however, is apparently not so powerfully antidotal as the antivenene obtained by the process of artificial protection.

The foregoing statements, although referring mainly to observations on the lower animals, have, probably in every particular, a very direct bearing upon both the prophylaxis and treatment of snake-poisoning in man.

Some little consideration of the details of the application of the antivenene and the employment of auxiliary measures may, however, be serviceable; and, equally of practical service, some consideration of the probable limitations to the capacity of antivenene as an antidote.

In the meantime, I cannot adduce any actual experience of its use in human beings, as although a considerable quantity, both in the liquid and dry state, was last summer sent to India, and a smaller quantity to Africa, no opportunity for using it as an antidote has as yet occurred in the districts to which it had been sent.

But, first, let me say in regard to the altogether unsatisfactory experience of the use of medicines, ordinarily so-called, that I am not prepared to take the extreme position that no good can be done by their employment. While the evidence shows that no one of the very large number of those that have been recommended as antidotes is able, in any conditions of administration, to prevent death after the reception of even the smallest lethal dose of venom, it still may be that, by the physiological effects which they produce, they may assist any efficient antidote, such as antivenene, in preventing death; and also, by prolonging life, increase the opportunity for a more thorough use of this antidote. In this category I would especially place medicines which increase excretion, such as diaphoritics and diuretics; many of the rapidly acting stimulants of the circulation, such as alcohol and the old snake remedy, ammonia; and stimulants of respiration, such as atropine and strychnine, the latter of which is enthusiastically championed by Dr. A. Mueller, of Sydney. And not only medicines, but also any measures that are available for these purposes, including artificial respiration, so distinctly indicated as a probably valuable therapeutical application in snake-bite by Fayrer and Brunton, which, though shown by the Indian Snake Commission to be incapable of preventing death when alone trusted to, was also shown to possess the valuable auxiliary power of prolonging life.

The first measure, however, that is usually and properly taken in the treatment of snake-bite, is to restrict, as far as possible, the absorption of the venom into the blood-vessels, from the place into which it has been injected by the poison-fangs, by separating this part from the more central parts of the body by a tight ligature. The efficiency of this measure, preventive rather than curative, is fortunately aided by the circumstance that snake-bites are most usually inflicted at parts to which a ligature can conveniently be applied; for in fifty-four cases collected by Wall, the part in nearly 89 per cent. of the cases was on the arms or legs. The ligature having been applied, whenever it is possible to do so, the next measure to adopt is to open up with a knife, to a considerable depth, the minute though deep punctures made by the fangs, and then to apply suction to the wound. Justification is found for this procedure in the fact, demonstrated by experiment, that notwithstanding the rapidity with which venom may be absorbed, a portion of it still remains for a considerable time in the tissues immediately surrounding the wound. This has been clearly demonstrated by both Kaufmann and Wall. The suction may be produced by the mouth, and in the absence of more effective apparatus this ready method would be serviceable, while it is attended with danger to the operator only in the infrequent occurrence of fissures or abrasions of the mouth. It is, however, more effectively and without any risk accomplished by a suction pump, such as the most useful pump invented by Mr. Andrew Smith, of Cape Colony, which I now show.

These steps having been taken, antivenene should be injected into the tissues at and near the wound and, also, under the skin above the ligature, and the ligature should not be removed until at least half an hour after a sufficient quantity of antivenene has been injected under the skin above it.

But the important question has yet to be answered, What is a sufficient quantity? The whole tenour of my remarks to-night has been to show how necessary it is to bear in mind that there is a definite relationship between the dose of venom received and the dose of antivenene required to antagonise it, and that this relationship also varies with the conditions of the administration of the antivenene, and, especially, with the interval of time that elapses between the reception of the venom and the administration of the antivenene.

In snake-bite in man it is impossible to estimate the dose of venom which has been injected, for the nature of the symptoms in the patient cannot give the information even approximately. In searching for a solution of this problem, several facts may be taken into consideration from which assistance may be obtained. And, firstly, what is the probable quantity of venom that a serpent injects into a wound? Some data for answering this question have, very kindly, been obtained for me by Brigade-Surgeon Lieut.-Colonel Cunningham, of Calcutta. Taking nine adult cobras, healthy and vigorous, he collected from each the venom ejected at a single bite, dried and weighed each collection separately, and sent me the weights. They are as follows;—

(1) 0·726 gramme.	(6) 0·113 gramme.
(2) 0·262 ,,	(7) 0·239 ,,
(3) 0·115 ,,	(8) 0·306 ,,
(4) 0·144 ,,	(9) 0·253 ,,
(5) 0·132 ,,	

The total venoms yield an average of 0·255 gramme for each bite; but, if the exceptionally large quantity stated in the first figure be excluded, the average for the remaining eight becomes ·195 gramme. It must also be considered that these quantities were obtained in the most favourable conditions for securing the total quantity ejected at a single bite, whereas in actual practice the conditions are less favourable for the insertion of the total available venom into the tissues of the victim.

Reverting now to determinations of the minimum-lethal dose for the lower animals, we find that if the minimum-lethal dose for the cat be adopted as being the same as that for man, the total quantity of dry cobra-venom required to kill a man of ten stones weight would be ·317 gramme, which is considerably more than the quantity, judging from the above averages, that a cobra is usually able to eject during a single bite. It would therefore appear necessary to assume that the minimum-lethal dose per kilogramme for man is smaller than for a cat; but, as it is probably greater than for a rabbit, we may for convenience assume that it is twice that dose. In this case, the smallest quantity required to produce death in a man of ten stones would be about ·0317 gramme, which, however, seems to be considerably less than the quantity which a fresh cobra has at its disposal. Applying now the facts that have been stated in the series of experiments where the smallest quantity of antivenene required to prevent death when injected thirty minutes after twice the minimum-lethal dose was determined, it will be recollected that that quantity is 5 cc. per kilogramme of animal. Taking this as a basis for the dose of antivenene, in order to prevent death in man from the estimated minimum-lethal dose of cobra-venom, so considerable a quantity as 330 cc., or about 11½ ounces, of antivenene would be required, if the antivenene be injected not much longer than thirty minutes after the bite had been inflicted. This, though a large, is by no means an impossible dose, and it could, without much inconvenience, be introduced under the skin at several parts of the body.

On the other hand, the estimate which I have adopted of the minimum-lethal dose for man may be too high a one, and if it should prove to be nearer that for the rabbit, then the quantity of antivenene required to prevent death, if administered half an hour after the snake-bite, would be reduced to about four ounces. It is also to be recollected that if dry antivenene be used, it may be dissolved in a much smaller quantity of liquid than is required to restore it to its original bulk.

As to the probability, in a fatal snake-bite, of the quantity of venom received by the victim being only about, and not much in excess of, the minimum-lethal dose, it would appear that, in many cases, even so large a dose is not introduced; for general experience indicates that the majority of persons who are bitten actually recover, whatever treatment is adopted. Sir Joseph Fayrer also shows, in his classical "Thanatophidia," that in 64 per cent. of fatal cases of snake-bite in India, the victims survived the infliction of the bite for periods of from three to twenty-four hours; and this duration of life implies that the dose of venom received, could not have been much greater than the minimum-lethal.

It must be admitted, however, that even for the minimum-lethal dose of venom, the quantity of antivenene required to prevent death in man is probably inconveniently large, especially if, in the treatment, reliance is placed solely upon the administration of antivenene, to the exclusion of all or several of the auxiliary measures to which I have referred. It is desirable, also, that the antivenene treatment should be a practical one, not only for doses of venom which do not much exceed the minimum-lethal, but also for the considerably larger doses that are occasionally introduced in snake-bite.

To attain this object, further work is required in order that there may be obtained an antivenene even more powerful than that whose antidotal capabilities I have described.

I am not sanguine that this will be accomplished by carrying to a higher degree the process of artificial protection in animals. A comparison of the antivenene of rabbits which had last received thirty times the minimum-lethal dose of cobra venom with that of other rabbits which had last received fifty times that dose, has shown that the latter has but little antidotal advantage over the former, and has suggested that, in the process of artificial protection, the saturation point of the blood for antivenene is reached before the possible maximum non-fatal dose of venom has been administered.

I would anticipate with more hope the results of endeavours to separate the true antivenomous principles from the inert constituents of the blood-serum with which they are mixed; and although the required chemical manipulations are attended with many difficulties, some success has already been obtained in effecting this separation.

In the foregoing remarks, it has, however, been shown that even with the antivenene whose properties have been described, human life may be saved in a considerable, if not in a large, proportion of the cases of snake-bite, which would otherwise terminate in death. The attainment of this result is a satisfactory one; for the mortality from snake-bite is large, and is not restricted to the 20,000 deaths which annually occur in India, but includes additional thousands in all the tropical and sub-tropical regions of the world. THOMAS R. FRASER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Drapers' Company have voted £50 to Mr. Percy Williams, a student at University College, London, towards paying his expenses of post-graduate study. Mr. Williams was placed first in honours in his chosen faculty at the B.Sc. Examination of last year in connection with the London University.

IT is stated that the total subscriptions promised for the new building fund of the University College of South Wales and Monmouthshire amounts to over £16,000. The Treasury has authorised the payment of £10,000 to the building fund, this being half the sum promised by her Majesty's Treasury on condition that £20,000 was collected in South Wales and Monmouthshire by July next.

THE University of Utrecht will celebrate its "260th lustrum" during the month of June next. The occasion will be rendered specially interesting by the *fêtes* which will be given by the students, and which will include their traditional masquerade and an elaborate old world tournament. It is expected that the ancient city will be visited by numerous strangers during the commemoration.

A MUNICIPAL school of science and art was opened at Bideford on Wednesday, April 15. For some time past instruction in science and art has been given with great difficulty in ill-fitted and unsuitable rooms. The cost of the new school will be about £3000, towards which the County Council have contributed £500 (with a promise of £75 towards science apparatus), the Science and Art Department will grant £650, and a penny rate has yielded £700.

WE learn from the *Athenæum* that the Committee of the Aberdeen University Council, which has been considering measures for the extension and better endowment of the university, has issued a report enumerating, "among its more pressing wants," the enlargement of the library, laboratory, and museums, a botanic garden, residential halls for both sexes, seven new professorships, and fifteen lectureships. The report also advises the establishment of an Aberdeen University Association, on the model of the Edinburgh Association.

ON Tuesday, April 14, the Right Hon. Sir William Hart-Dyke visited Bath and opened the northern wing of the new municipal buildings which has been appropriated to the purpose of technical schools. The building, which cost £30,000, was commenced about eighteen months ago, and comprises four floors. The basement consists of workshops and mechanical and electrical laboratories; the ground-floor includes large and small lecture-rooms, and accommodation for the library and lecturers' and director's rooms. The first-floor constitutes the school of art, while the second-floor contains a domestic department and chemical and physical laboratories.

A CONFERERCE on Secondary Education was opened on Tuesday in the Senate House, Cambridge, under the presidency of the Vice-Chancellor of the University. A resolution generally approving of the scheme set forth in the report of the Royal Commission on Secondary Education, and expressing a hope that legislative measures in accordance with that report would be passed, was carried by 128 to 41 votes. A resolution approving the establishment of local authorities for secondary education was also carried, after considerable discussion. Resolutions were subsequently agreed to in favour of the establishment of a separate central authority for secondary education, and of the preservation of the freedom, variety, and elasticity which have hitherto characterised secondary education in England.

THE following are among recent appointments abroad:—Dr. Paul Czermak, *privat-docent* in Physics in Gratz University, to be extraordinary professor; Mr. James Edwin Lough to be instructor in experimental psychology in Harvard University; Dr. Charles Palache, instructor in mineralogy, and Mr. R. J. Forsythe in metallurgy and metallurgical chemistry; Baron Eötvös to be full professor of experimental physics in the University at Buda-Pesth; Dr. O. Hildebrand to be extraordinary professor of surgery in Berlin University, and Dr. Oestreich to be *privat-docent* in general and anatomical pathology; Dr. Klecki to be *privat-docent* in general and experimental pathology at Cracow.

THE new Franco-Scottish Society was inaugurated in Paris last week at the Sorbonne. The objects of the Society are to bring the universities of France and Scotland into connection with each other by study in the one and the other of their respective students, to bring about intercourse between their professors and other officers, to promote historical research concerning the ancient relations between the two countries, in general by periodical meetings held in France and Scotland, and all other means, to renew, as far as possible, the bonds of sympathy between them. About forty delegates attended on behalf of the Scottish universities and interest in higher education; and on the French side, the Paris University and Upper Schools were represented by their chief authorities. Among the subjects discussed was the place of political science in higher education. The congress terminated with a banquet, at which M. Jules Simon presided, given to the Scottish guests by their French colleagues on Saturday.

REFERRING to the late Mr. George Holt, whose death we briefly announced a fortnight ago, the *Lancet* remarks that he took the greatest interest in University College, Liverpool—an interest substantially shown by his first subscription of £10,000 which was requisite to complete its equipment for incorporation in the Victoria University. It was in its medical school that he took a special interest, and his benefactions to it have been numerous. The chairs of Physiology and Pathology were endowed by him in the amount of £10,000 each, to which was added a further sum of £10,000, for the maintenance of laboratories in those branches of investigation. In addition to these benefactions he presented its medical faculty in 1886 with the sum of £2000 for distribution during the ten succeeding years in tutorial scholarships of the value of £100 each. He further fitted up in a complete manner Ashton Hall as a pathological and bacteriological laboratory, which is one of the most complete of its kind in this country. This does not exhaust the list of his benefactions; a further sum of £1000 was given as a donation to the college library, to be expended in annual instalments of £100. He was also a generous contributor to the maintenance fund of the college and a warm friend of education in general. Indeed, it is probably as a benefactor of University College that his name will live longest in local memory.

THE Teacher's Registration Act, which was recently introduced in the House of Commons without comment, is a direct outcome of the work of the late Commission on Secondary Education. Though the Registration Council which it is proposed to establish is not exactly that suggested in the Report of the Commissioners, it will prove quite satisfactory to most of those whose interests are concerned. The Council is to consist of eighteen members—six, appointed by Her Majesty with the advice of her Privy Council; six, elected by the Universities, one by each of the following—Oxford, Cambridge, Durham, London, Victoria, and Wales. Two members chosen by registered teachers engaged otherwise than in elementary schools, two chosen by elementary teachers, and two by registered teachers generally. It is provided by the Act that no person shall be admitted to the register unless he possesses (*a*) "a degree or certificate of general attainments which is granted by some university or other body recognised for that purpose by the Council, and is accepted as satisfactory by the Council; (*b*) a certificate or diploma of adequate knowledge of the theory and practice of education and of practical efficiency in teaching, which is granted by some university or other body recognised for that purpose by the council." Teachers in elementary schools are to be admitted to the register on the same terms as those engaged in secondary schools. It is further to be enacted that if any person (*a*) "wilfully makes or causes to be made any falsification in any matter relating to any register under this Act, or (*b*) by false representation procures himself to be registered under this Act, or not being so registered fraudulently represents himself as being so registered, he shall be guilty of misdemeanour, and shall on summary conviction be liable to be imprisoned with or without hard labour for any term not exceeding twelve months." Teachers of proved attainments and competence who are at present engaged in teaching are to be admitted to the first register.

SCIENTIFIC SERIALS.

THE numbers of the *Journal of Botany* for March and April are again almost entirely occupied by descriptive papers.—Mr. G. Murray describes a new species of *Caulerpa* from South Africa. A number of new fungi are described by Mr. G. Massee, including a new genus *Clypeum*, with no near affinities.

THE second part of vol. vii. of Cohn's *Beiträge zur Biologie der Pflanzen* contains three papers.—Dr. O. Kirchner describes the root-tubercles of the Soja-bean, which, like those of other plants belonging to the pea-tribe, are caused by a microbe; large quantities are found imbedded in the tissue of the tubercle, and he regards them as belonging to a new species, which he names *Rhizobacterium japonicum*, found in the soil of Japan. As in other cases, the relation of the microbe to the host is a symbiotic one, enabling it to absorb into its tissues the free nitrogen of the atmosphere.—T. Rosen contributes a chapter to his *Beiträge zur Kenntniss der Pflanzen-zellen*, in an account of the nuclei and nucleoles in meristematic and sporogenous tissues. It is a very important contribution to our knowledge of the intricate phenomena connected with cell-division, and of the part played by the nucleus and its nucleoles in the process.—Dr. E. Heinricher describes the structure and function of the haustoria of the parasitic genus *Lathræa* or toothwort, especially of the two species *L. squamaria* and *L. clandestina*. From various points of structure he concludes that *Lathræa* is more nearly allied to the typical *Scrophulariaceæ* through *Rhinanthus*, than it is to the *Orobancheæ*, under which it is usually placed.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 10.—"Helium: a Gaseous Constituent of certain Minerals. Part II. Density." By William Ramsay, F.R.S.

The gas obtained from the minerals bröggerite, samarskite, and fergusonite is rich in hydrogen, but contains only an infinitesimal quantity of nitrogen; carbon dioxide and helium are also evolved, but no gas of new spectrum, even in samples not passed through the usual absorbents, soda-lime and phosphoric anhydride. From 1 gram of clèveite, 7·2 c.c. of helium is obtainable; 1 gram of bröggerite yields less than 1 c.c.; 1 gram of samarskite, about 0·6 c.c.; and 1 gram of fergusonite 1·1 c.c.

The density of the samples of gas from these various minerals appears to show small, but real differences. That from clèveite was found to be 2·205 (oxygen = 16), but Langlet found a sample from the same source to possess the density 2. The helium from bröggerite has the density 2·18; that from samarskite 2·12, and that from fergusonite 2·14. These differences are small; but as they are the means of several determinations with different preparations, and as the individual determinations differ less among themselves than the densities of specimens from different minerals, there appears ground for the supposition that helium is a mixture. The possibility of this conclusion is strengthened by the fact that the relative intensity of the lines in the spectrum of the gas from clèveite is different from that of the samples from bröggerite, samarskite, and fergusonite; and this difference, indeed, is visible without the aid of a spectroscope, for the clèveite gas has a richer shade of yellow, tending towards orange, than that from the other minerals; the colour of such samples is a purer yellow. Moreover, there are certain faint lines in the blue-green in the spectrum of the clèveite gas, which have not been observed, even under the most favourable circumstances, with "end-on" tubes, in that of the gas from other sources.

The author is engaged in an attempt to separate the possible constituents of helium.

"Angular Measurement of Optic Axial Emergences." By William J. Pope.

The ordinary methods of determining the angle, α, between the direction of emergence of an optic axis into air and the normal to the crystal plate, being very inaccurate unless the plate has a highly polished surface, the author has devised a new method by which this angle, α, can be determined to within 2 or 3 minutes of arc. The crystal is mounted in the Fuess axial angle apparatus, and a reading taken for the air emergence of the optic axis; a cell containing oil of known refractive index, μ, is then brought up round the crystal plate, and a new reading taken for the oil emergence of the optic axis. From the difference of the two angular readings, $\alpha - \theta$, the angle α may be calculated from either of the formulæ

$$\cot \alpha = \cot (\alpha - \theta) - 1/\mu \sin (\alpha - \theta)$$

or

$$\tan (\alpha + \theta)/2 = \mu + 1/\mu - 1 \tan (\alpha - \theta)/2.$$

Series of test measurements are given, proving the efficacy of the method; when α is 53° 24′, and μ is 1·6473, the measured value of $\alpha - \theta$ is 24° 15′, a fairly large angle. Oil of the highest attainable index of refraction should be used in order to obtain maximum values of $\alpha - \theta$; the refractive indices are conveniently determined by aid of the Pulfrich total-refractometer.

March 26.—"Additional Report on Erect Trees containing Animal Remains in the Coal Formation of Nova Scotia." By Sir J. William Dawson, F.R.S.

Linnean Society, April 2.—Mr. J. G. Baker, F.R.S., Vice-President in the chair.—On behalf of Dr. F. Arnold, of Munich, the Secretary exhibited several photographs of typical lichens, received in continuation of a series which has been for some time past in course of issue by that well-known lichenologist.—Mr. M. F. Woodward exhibited a very young example of the "Spiny Ant-eater," *Echidna aculeata*, taken from the mammary pouch of the parent at Newcastle, Western Australia, by Mr. H. B. Woodward, Curator of the Perth Museum. It was intermediate in size between two stages described by Prof. Parker, but showed no trace of the calcaneal spur characteristic of the male, nor any trace of the mammary pouch peculiar to the female. He called attention to the flattened and beak-like character of the snout and the vestiges of the "egg-breaker," and to the disposition of the spine papillæ. For the purpose of comparison, Mr. Woodward exhibited also the heads of *Ornithorhynchus* and *Echidna*, and a male and female mammary fœtus of *Perameles*.—A paper was read by Mr. C. H. Wright, "On the Genus *Stemona*, Lour.," one of the few monocotyledonous genera whose flowers are constructed on a tetramerous type, and remarkable for the diversity of its vegetative characters, while its floral structure varies between comparatively narrow limits.—Lieut.-Colonel C. T. Bingham, in a paper on some exotic fossorial Hymenoptera in the British Museum (communicated on his behalf by Mr. W. F. Kirby), enumerated thirty-four species, of which no less than thirty were previously undescribed. The discovery of many of these was due to the researches of the author, who had spent twelve years collecting in Sikkim, Burma, and Tenasserim.—The President then gave a descriptive account of the Khasia Hills from personal experience, dwelling on their geological formation, the extraordinary rainfall of the district (120 inches in five days), and the chief characteristic features of the flora and fauna.

Royal Meteorological Society, April 15.—Mr. E. Mawley, President, in the chair.—Mr. W. Ellis, F.R.S., read a paper on the mean amount of cloud on each day of the year at the Royal Observatory, Greenwich, on the average of the fifty years 1841–90, in which he showed that a principal maximum occurs in winter and a principal minimum in autumn, with a secondary much less pronounced maximum in summer and a secondary minimum in spring. There is, however, considerable irregularity in the succession of daily values, the differences between which on consecutive days are in numerous cases relatively large. Cloudless days are most numerous in spring and autumn, and least so in winter and summer; days of little cloud are somewhat less numerous in winter as compared with other parts of the year, whilst days of medium cloud are much more numerous in summer than in winter. Days of much cloud are nearly equal in amount in all parts of the year; whilst overcast days are much more numerous and nearly equal in amount in the first and fourth quarters of the year, much less numerous in the second quarter, and again less numerous in the third quarter.—Mr. E. D. Fridlander gave an account of some observations of the amount of dust in the atmosphere made at various places during a voyage round the world in 1894–95. The experiments, which were made with a form of Aitken's pocket dust counter, showed that there are often considerable variations in the number of dust particles in a very short space of time. Not only did dust occur in the air of inhabited countries, over the water surfaces immediately adjoining them, and up to an altitude of 6000 or 7000 feet amongst the Alps, but it was also found in the open ocean, and that so far away from any land as to preclude the possibility of artificial pollution, and its existence has been directly demonstrated at a height of more than 13,000 feet.—Major H. E. Rawson gave an analysis of the Greenwich rainfall records from 1879 to 1890, with special reference to the declination of the sun and moon.

EDINBURGH.

Royal Society, April 6.—Rev. Prof. Flint in the chair.—A communication by Drs. Stewart and Young, of the Public Health Laboratory, Edinburgh University, on the bacteria in milk as supplied in Edinburgh, and the relative efficiency of different methods for their removal, was read by the former. Since 1894, samples of milk from dairies all over the town had been examined, and it was found that bacteria were most numerous between July and October. The milk from dairies with cow-houses in town contained, five hours after milking, more than eight times the number of micro-organisms in milk from dairies supplied from the country. Methods for sterilising were described, but each imparted a boiled taste to the milk. Scalding, at 176° F., would keep the milk sterile for twenty-four hours if great care were taken, but when performed on a large scale there could be no guarantee, owing to possible post-scalding contamination, that the bacillus of tubercle and diphtheria were not present.—Dr. J. Macintyre, Glasgow, indicated some new results which he had got with the Röntgen X-rays. He described his methods for reducing exposure and obtaining definition, and exhibited photographs of different parts of the skeleton of the living subject. Among these were that of one side of the head, obtained by putting the tube so near the other side that its image was eliminated, the sternum and ribs, and the vertebral column with scapula and clavicle. Dr. Macintyre described screens of different kinds which he had made, of which the one saturated with barium platinocyanide was the best. He suggested the use in surgery of fluorescent screens for the cavities, such as the mouth, throat, and maxillary antrum, and exhibited the result of an attempt at photographing tissue. In the kidney, from a cadaver shown, the distinctive in structure of the different parts, and the presence of a calculus, were quite apparent.—Dr. W. G. Aitchison Robertson read a summary of an investigation regarding the digestion of starch in the stomach. He showed under what conditions, normal and abnormal, amylolysis ceases in the stomach, and the effect which the gastric secretion has on the ferment ptyalin.—A communication from Lord Kelvin on impulsive fluid motion was held as read.

PARIS.

Academy of Sciences, April 15.—M. A. Cornu in the chair.—On fallow ground, by M. P. P. Dehérain. The ancient practice of allowing land to lie a year fallow after three years cultivation is shown to have rested upon a sound basis, the land increasing considerably in nitric nitrogen during the fallow year. With modern manures the necessity for this no longer exists, although the practice still survives in many parts of Europe.—Nitrates in spring water, by M. T. Schlœsing.—On a letter from Gauss, of date June 16, 1805, by M. de Jonquières. The letter was written to M. Delisle, Professor of Mathematics at Orleans.—On the products of combustion of an acetylene burner. Explosive mixtures of acetylene and air, by M. N. Gréhant. The combustion of acetylene in an ordinary fish-tail burner is complete, the products not comprising the least trace of a combustible gas containing carbon. With mixtures of acetylene and air the most violent explosion was produced when the volume of air was nine times that of the acetylene.—On certain classes of Laplacian equations with equal invariants, by M. A. Thybaut.—Verification of Kerr's law in absolute measure, by M. Jules Lemoine. By the use of a condenser having carbon disulphide as the dielectric, with potentials varying from 5000 to 35,000 volts, Kerr's law was found to be correct to within at least 1 per cent. The absolute value of the constant for carbon bisulphide is $3 \cdot 7 \times 10^{-7}$.—On electrified Röntgen rays, by M. A. Lafay. A verification of results previously published. It was found that it was a matter of indifference, in deviating the Röntgen rays, whether they were electrified before or after traversing the magnetic field.—The action of the Röntgen rays upon double and triple electric layers, by M. N. Piltschikoff. The rays discharge the double electric layer very slowly, if at all.—On the mechanical action emanating from Crookes' tubes, by MM. A. Fontana and A. Umani. A claim for priority.—Application of photography by the Röntgen rays to analytical researches on vegetable materials, by M. F. Ranwez. The adulteration of vegetable products with mineral substances, such as saffron with barium sulphate, is readily detected by the differences in the shadows cast by the X-rays.—On homolinalool and on the constitution of licareol and licarhodol, by MM. Ph. Barbier and L. Bouveault.—Action of the sodio-cyanacetates of propyl, butyl, and amyl upon diazobenzene chloride, by M. G. Favrel. The hydrazones obtained exist in two isomeric modifications, distinguishable by their melting points.—On the diurnal lunar wave and on the secular variation of the barometer, by M. P. Garrigou-Lagrange. The action of the moon on the atmosphere is well marked. On the tenth parallel of latitude, the waves caused by the moon may amount to 1·2 mm. of mercury.—On the principal results of the last ascent to a great height of the balloon *Aerophile* (March 22 1895), by MM. G. Hermite and G. Besançon. At a height of eight and a half miles the minimum temperature recorded was $-63°$ C., or a fall of 1° per ·597 feet.—Animal temperatures in the problems of evolution, by M. Quinton. The temperatures prevailing on the globe in the remote past were higher than at present, owing to the gradual cooling of the globe. An animal whose life process was in equilibrium with a given temperature when the temperature commences to fall, must do one of two things—either adapt its chemical and physiological changes to the surrounding temperature, as in the case of the pepsin of a reptile, which will act on a food at temperatures near 0°, or may tend to artificially maintain the temperature of the body, by developing heat. Thus in one group of animals, whose evolution had ceased before appreciable cooling had set in, the greater the antiquity the smaller ought to be their power of developing heat. With animals, on the contrary, whose evolution had been prolonged into the cold ages, the reverse would be the case, the body temperature being the lower, the older the animals. Experimental figures confirm these theoretical reductions.

Berlin.

Physical Society, March 13.—Prof. von Bezold, President, in the chair.—Dr. Lindau, of Munich, spoke on the cooling of gases during their adiabatic expansion, and showed that from this the specific heat of the gases may be determined. In opposition to this view Prof. Planck pointed out that the cooling does not depend solely on specific heat, but also on the extent to which the gas differs from the condition of a perfect gas.—Dr. Orlich demonstrated how every phasic variation of alternating currents may be shown by means of two of Rubens' vibration-galvanometers placed at right-angles to each other. He intends to carry out further experiments in order to see whether the variations are measurable by this method.—Prof. A. König made a communication on the absorption spectra of visual purple from various vertebrates, and on visual yellow, which he had only once been able to investigate as obtained from the visual purple of a human retina, whereas the visual purple of other vertebrates never yielded visual yellow. He hoped to be able to control this single observation, should the chance of so doing present itself.

March 27.—Prof. Warburg, President, in the chair.—Mr. Archenholz reported on his experiments with a view to testing the statements of Le Bon as to black light. He showed how great is the difficulty of completely excluding all lateral light even by using metallic screens, and exhibited photographs in support of this, and came finally to the conclusion that Le Bon's black light is merely a false light. Experiments made with Balmain's material on the permeability of wood and metal by phosphorescent rays were similarly negative.—Prof. Goldstein spoke on the means for increasing the intensity of Röntgen X-rays, of which he mentioned two. The first consists in using the rays which are emitted forwards by the phosphorescent substances, since they are much more intense than those that have passed through the substances. The second consists in the employment of potassium platinocyanide, which emits a blue light acting very rapidly on photographic plates. Further, a plate had recently been prepared by Siemens and Halske, which gives a clear image of the hand in a few seconds by Röntgen's rays, and finally Kahlbaum has prepared a barium platinocyanide which similarly materially shortens the necessary exposure.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Treatment of Phthisis: Dr. A. Ransome (Smith, Elder).—Handbook for the Bio-chemical Laboratory: Prof. J. A. Mandel (Chapman).—A Compendium of General Botany: Dr. M. Westermaier (Chapman).—Modern Stone-Cutting and Masonry: J. S. Siebert and F. C. Biggin (Chapman).—Meteorological Observations made at the Adelaide Observatory, &c., 1891, 1892, 1893 (Adelaide).—The Water Supply of the City of New York, 1658-1895: E. Wegmann (Chapman).—The U.S. Public Works: Captain W. M. Black (Chapman).—Cholera in Indian Cantonments, and how to deal with it: E. H. Hankin (Cambridge, Deighton).—James Clerk Maxwell and Modern Physics: R. T. Glazebrook (Cassell).—An Elementary Treatise on the Calculus for Engineering Students: J. Graham (Spon).—Les Tramways: R. Seguela (Paris, Gauthier-Villars).—Astronomie, Astrophysique, Géodésie, Topographie et Photogrammétrie: G. Towne, 2 Vols. (Paris, Bertaux).

Pamphlets.—Medical Inspection of, and Physical Education in, Schools: C. Roberts (Bale).—Weitere Ausführungen über den Bau der Cyanophyceen und Bacterien: Prof. O. Bütschli (Leipzig, Engelmann).—Stonyhurst College Observatory. Results of Meteorological and Magnetical Observations, 1895: Rev. W. Sidgreaves (Clitheroe).—Colonial Origins of New England Senates: F. L. Riley (Baltimore).—Licht-, Elektricitäts- and X-Strahlen: R. Mewes (Berlin, Krayn).—Die Fortpflanzungs-Geschwindigkeit der Schwerkraftstrahlen: R. Mewes (Berlin, Krayn).

Serials.—Proceedings of the Physical Society of London, Vol. xiv. Part 4 (Taylor).—Journal of Anatomy and Physiology, April (Griffin).—Royal Natural History, Part 30 (Warne).—Journal of the Chemical Society, April (Gurney).—Journal of the Institution of Electrical Engineers, April (Spon).—Microscopical Studies in Botany, March (Jersey, Hornell).—Mind, April (Williams).—Contributions from the U.S. National Herbarium, Vol. iii. No. 7 (Washington).—American Journal of Mathematics, Vol. xviii. No. 2 (Baltimore).—Internationales Archiv für Ethnographie, Band ix. Heft 2 (Leiden, Brill).

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