THURSDAY, FEBRUARY 13, 1908.

## IS MARS HABITABLE?

*Is Mars Habitable? A Critical Examination of Prof. Lowell's Book, "Mars and its Canals," with an Alternative Explanation.* By Dr. Alfred Russel Wallace, F.R.S. Pp. xii+110. (London: Macmillan and Co., Ltd., 1907.) Price 2*s.* 6*d.*

IN the year 1903 Dr. Wallace published an interesting and fascinating volume entitled "Man's Place in the Universe," a book which created quite a large perturbation in the thinking world. In it he marshalled together a great number of lines of astronomical research, pointed out the deductions which had generally been made from them, and by weaving them together in a masterly way, drew some very definite conclusions from them.

These conclusions he "claimed to have shown to have enormous probabilities in their favour," and two of them, which need only here be mentioned, were as follows:—

(1) That no other planet in the solar system than our earth is inhabited or habitable.

(2) That the probabilities are almost as great against any other sun possessing inhabited planets.

Not only, then, was a wet blanket thrown over many of our favourite dreams relating to the probable doings of living creatures in other worlds, but quite a shock was received when our near neighbour Mars was ruled out of court and declared to be uninhabitable!

We had all become accustomed to regard the changes of hue on the planet's surface as due to the varying tints of waxing and waning vegetable growth. We pictured to ourselves the great ice caps melting away under the heat rays of the approaching summer sun. The gemination of the canals and the later duplication of some of them were the means of making the best use of the water after its release from the poles, and the oases served as distributing centres. These and many other variations of absorbing interest all tended to indicate a world of change, very different from the serenity on, let us say, the moon, but more approximating to those of the earth when seen from afar.

If we are to take the view of the writer of this book, such changes must be looked on rather as signs of death than of life, since water, he says, there is none.

During the last decade or more the planet Mars has received a considerable amount of attention. By the energetic, persevering, and painstaking astronomer Prof. Lowell, every portion of the planet's surface has been under close observation, and the surface features have been chronicled on nearly every occasion when favourable opportunities presented themselves.

It is not too much to say that just as the name of Schiaparelli is now, and will always be, identified with the planet Mars, so will that of Lowell be handed down to posterity for his magnificent consecutive series of observations.

In the year 1905 Prof. Lowell published a very valuable volume describing in great detail, and copiously illustrated with sketches and charts, the observations made by him at the oppositions of 1894, 1896, 1898, 1901, and 1903.

In 1906 he published a volume which was intentionally devoid of technicalities. This was meant to contain a summary of the main results, derived from the discussion of all the data, and his own deductions as to the probable cause or causes of the surface features and their changes. He was led finally to make the following statement with regard to the habitability of Mars:—"That Mars is inhabited by beings of some sort or other we may consider as certain as it is uncertain what those beings may be."

This very definite statement, made after the issue of Dr. Wallace's book to which reference above has been made, has called into being the present small volume by the same author. Although, as we read in the preface, it was commenced as a review article on Prof. Lowell's recent book, it became so extended that it was considered expedient to publish a more detailed examination of the various physical problems involved in order to give a complete presentation of the opposite view held by Prof. Lowell.

In directing attention to the contents of this book it is not proposed to enter into each point of the arguments dealt with, but it will be sufficient to refer briefly to some of them.

The first two chapters are devoted to a general survey of the observations of Mars made by early workers, concluding with those made by Prof. Lowell. With regard to the last-mentioned, the author pays a high tribute to the technical skill and persevering labour of Prof. Lowell, and, while accepting all his observations as valid, only parts company with him "as regards the startling theory of artificial production which he thinks alone adequate to explain them."

The two main topics dealt with in chapter iii. are the questions of the elaborate system of the canals and the water supply. The author takes the view that if the surface of the planet is so wonderfully smooth and level as Prof. Lowell states it to be, then the great network of straight canals could possibly have been constructed by intelligent beings for irrigation purposes. But he points out emphatically here that, if it were so smooth, then such a system would be quite unnecessary, as the water would naturally irrigate as much of the surface as it could reach. If it be admitted for a moment that the polar caps are frozen water, he joins with the late Miss Clerke in the view that the excessively scanty supply of water, coupled with the loss through evaporation, could not possibly serve the innumerable canals.

As the habitability of Mars depends on the presence of water, the question of the evidence for the presence or absence of water vapour is dealt with in chapter iv. Dr. Wallace first directs attention to the observation of the melting polar caps, and the deduction made by Prof. Lowell that this melting and re-forming affirm the presence of water vapour in the atmosphere. It will be remembered that Prof. Lowell observed blue borders on the edges of the polar caps as they melted,

and he stated that "water alone could do this." The author entirely disagrees with this interpretation, "the only proof," as he says, "he gives that the caps are frozen water." He points out that for water to be blue it must be deep, and this cannot be so on Mars because its surface is so level.

He finally indicates that there are two very important pieces of evidence which point to a lack of water vapour on the Martian planet—the spectroscopic evidence, which must be taken into account, entirely negatives the view of the presence of water vapour; and Dr. Johnstone Stoney's proof that aqueous vapour cannot exist permanently there, or on any planet, unless its mass is at least a quarter that of the earth. As the mass of Mars is only one-ninth that of our earth, the planet must have parted with its water vapour many, many centuries ago.

In the next chapter the important question of the probable temperature of the planet is taken in hand, and the author shows to his own satisfaction, and probably to that of the majority of his readers, that the temperature must be far too low for the possibility of any formation of a high form of organic life. He introduces also a note stating the view on this point given previously by Prof. J. H. Poynting, who showed that unless an assumption be made that there exists some quality in the atmosphere of Mars entirely different from any found in our own, the temperature of Mars cannot be as high as the value given to it by Prof. Lowell.

The author ingeniously considers the condition of the Martian atmosphere as being intermediate between that of the earth (a dense atmosphere) and that of the moon (practically no atmosphere). He then refers to many researches on lunar radiation as regards measurements made on portions of the surface exposed and unexposed to the sun's rays. He recalls the important function of a planetary atmosphere, like that, for instance, of our own earth, in retaining and cumulating solar heat and reducing radiation into space. He finally deduces that the Martian conditions of temperature must approximate more to those of the moon than to those of the earth. Further, he lays great stress on the impossibility of the seasonal change at the Martian poles being an apparent freezing and thawing of water, and he expresses his view in the following words:—

"If the moon, even at its equator, has not its temperature raised above the freezing point of water, how can the more *distant* Mars, with its *oblique* noonday sun falling upon the snow-caps, receive heat enough, first to raise their temperatures to 32° F., and then to melt with marked rapidity the vast frozen plains of its polar regions?"

In the chapters referred to above the author has presented his views as to the extreme probability of a very low temperature and of the absence of water vapour on Mars, and consequently replies to the question "Is Mars Habitable?" in the negative.

In the remaining portion of the book he makes an alternative suggestion as to the cause or origin of the surface markings and changes recorded on the planet. Just as he stated he had to part company with Prof. Lowell when he considered the latter's deductions drawn from the discussion of his facts, so we must part company with Dr. Wallace, and disagree with his views on the peculiar, and what seems unique, origin of the planet Mars.

It may be recalled that Prof. W. H. Pickering, next to Prof. Lowell, has made the most minute study of the Martian surface details during the last decade or more. Further, he had the advantage of making his observations under practically similar climatic conditions, and, in addition, he has also closely studied the lunar features under specially fine instrumental and atmospheric conditions.

Prof. Pickering's suggested origin of the Martian canals is that they, like the rifts and streaks on the moon, are caused by volcanic action due to internal stresses set up by the cooling of the planet's heated interior. Dr. Wallace refers here to Prof. Pickering's work, and, like him, looks upon the canals and oases as the results of cooling.

In order, however, to create conditions on a planet which, when cooling, should be capable of producing an enormous network of fissures of large dimensions, and thus give a representation of the chief surface markings as seen on Mars, he suggests the following very ingenious but very questionable mode of planetary formation, rather straining even the very flexible meteoritic hypothesis.

He supposes that the planet began to be formed on the principle of the meteoritic hypothesis, but that the aggregation of the meteorites involved in the process took place so slowly that the heat generated by the bombardments was lost equally quickly by radiation. So gradual, he suggests, did this state of things occur that the planet attained its present size, minus about 50 to 100 miles of the radius, having grown to this dimension "as a solid and cold mass."

He then tells us that this cold mass, in its revolution round the sun, at a later stage of its life, passed through at each revolution a large and dense mass of meteorites. So violent were the impacts that the "inpour of the fresh matter first heated and later on liquefied the greater part of it, as well perhaps as a thin layer of the planet's original surface."

In this way the author produces a thin shell of liquid or plastic material covering a solid and cold interior, which he requires for the explanation of the surface features of Mars. At the termination of this series of annual bombardments this thin shell of heated material would rapidly cool, and, as it is superimposed on a globe of cool matter, craterlets would first be formed, and subsequently large fissures due to contraction. The fissures would have no regard for the equator, but would cross from one hemisphere to the other, as the canals are recorded to do.

The superficial tensions would render the cracks eventually very broad and deep, and where they crossed each other, holes, giving the appearance of oases, would be formed. In time, both fissures and oases would gradually crumble away at their sides, in consequence of the alternate expansion and contraction of the material, due to the presence or absence respectively of the sun's heat.

Although the author accounts for many of the other surface features and changes as recorded on the Martian disc, he is unable to suggest any satisfactory explanation of the doubling of the canals.

Enough, perhaps, has been said to indicate that in these pages we have some very original ideas on a subject of all-absorbing interest. It must nevertheless be left to the reader to form his own judgment as to the probability of the views put forward when he has carefully read the book.

We can unhesitatingly recommend this book to a very large circle of our readers, and more especially to those who have followed the previous publications relating to this subject. The last word on this difficult question has not been said yet, and the present issue will very likely re-kindle the flame.

WILLIAM J. S. LOCKYER.

## *AGRICULTURE IN FRANCE.*

(1) *Races bovines. France—Étranger.* Pp. 426. Price 5 francs. (2) *Races chevalines.* Pp. viii+467. Price 5 francs. By Prof. Paul Diffloth. Encyclopédie agricole. Zootechnie. (Paris: J. B. Baillière et Fils, 1908.)

IN the first of these volumes of the Encyclopedia Prof. Diffloth claims that special attention has been paid to varieties, to methods of selection and to breeding, and the author is to be congratulated on the success of his efforts. The book is a very valuable contribution to our knowledge of domesticated cattle; it treats, with commendable breadth and sufficient detail, not only of the characteristics of a great number of breeds and varieties of those breeds, but of certain of the physical conditions under which they thrive and of their geographical distribution.

Part i., which occupies thirty-four pages, begins with a short description of external features, head, body, limbs, teeth, horns, coat and colour, followed by brief notes on some of the anatomical variations which are specially marked in different races.

Part ii. fills the remainder of the book. The classification adopted by the author is based partly on Sanson's scheme of skull measurement, by which all species are divided into two main groups in accordance with the angle formed by a line drawn across the forehead at the base of the horns and a line from the base of one horn to the outer edge of the eye of the same side. When the angle so formed is a right angle, the type is recognised as brachycephalic, when it is obtuse as dolicocephalic. It is pointed out, however, that such classification is by no means a sufficient guide, and that various other external features, such as the form of the crest between the horns, the curve of the horns themselves, &c., must also be taken into account for practical purposes.

Twelve main races are recognised, and these are again subdivided into eighty-five varieties, as follows: —

(1) Low countries, with fifteen varieties; (2) German, three varieties; (3) Irish, five varieties; (4) Alpine, eight varieties; (5) Aquitaine, eight varieties; (6) Scythian, eight varieties; (7) Vendéenne, seven varieties; (8) Auvergnate, three varieties; (9) Jurassic, fourteen varieties; (10) Ibérique, six varieties; (11) Asiatic, seven varieties; (12) Scotch, represented only by the breed of that country.

Each variety is described; its origin, relation to other breeds, and the effects of crossing are discussed; its special capabilities are examined; the physical conditions of the geographical area it inhabits are generally noted, and their possible effect upon the breed is referred to.

A series of seven maps is of special interest. They are designed to show the areas over which certain races and varieties range, and in some cases their special breeding area is further distinguished. With two exceptions these maps refer to French breeds, the Dutch and Austro-Hungarian races being the only others so treated. This scheme is a most suggestive one, and if consistently carried out would be a very valuable aid both to the student and the practical breeder.

The text is full of valuable information concisely and clearly presented, especially valuable to English readers where it treats of French breeds. Besides figures in the text, many of which leave very much to be desired, there are forty plates, photogravures of selected animals.

The space at our disposal allows of only a very brief notice of the second volume. This book is equally carefully compiled, and is a valuable aid to the student, especially in relation to the natural conditions under which the various races and varieties of the horse thrive.

The author's classification scheme will not, perhaps, satisfy many authorities, but his descriptions of the characteristics of the very numerous varieties he recognises are clear and unbiased, and the figures and plates are good.

His statistics regarding the horse population of the world are no doubt open to criticism, but they cannot be questioned in relation to the conclusion he draws that the advent of the motor-car and agricultural machinery has been followed by an increase both in the numbers and value of horses. The view that Government aid is necessary for the breeding of certain classes of horses in this country receives substantial support from the author's description of the results gained by the care given and the large sums expended by his own Government for this purpose. Short chapters on the ass and the mules conclude the volume.

## *CHEMISTRY IN THE SEVENTEENTH CENTURY.*

*Medico-Physical Works of John Mayow* (1674). Pp. xxiii+331; with 6 plates. (Edinburgh: The Alembic Club, 1907.)

ALTHOUGH the name of John Mayow is well known to chemists, there are few who are acquainted with his works. Even the majority of the historians of chemistry have been content to acquire

their knowledge of him at second hand, so that his discoveries and views are generally stated with more or less inaccuracy. This becomes clear on perusing the present work, a translation from the Latin of Mayow's five treatises, for which we are indebted to the Alembic Club.

The basis of Mayow's work was his recognition of the existence in the air and in common nitre of extremely subtle particles to which he gave the name "nitro-aërial spirit." He did not, however, as is often supposed, regard air as a mixture of two gases, as we do to-day, but considered the nitro-aërial particles to be "fixed in the aërial particles themselves," and to be "torn from them by the burning of a lamp or the breathing of animals." They are, in fact, "neither air itself nor some material interspersed among its particles." Whilst the generally received opinion is correct that Mayow recognised that an increase of weight occurs when metals are burnt in air, it is also true that he made but little use of this fundamentally important observation; in the main his experiments were purely qualitative, and ingenious as they often were, they served in many cases to distract the attention from the real issue. Had it been otherwise the course of chemical history might have been different.

When it is remembered that, in Mayow's time, fire and air, mercury, sulphur, and salt were regarded as the fundamental elements, the clearness and originality of his views is very striking. He substitutes his nitro-aërial spirit (which we now call oxygen) for air and fire, and considers that out of the conflict of this spirit with "sulphur" (that is, the combustible constituent of substances) "all the changes of things arise." At each step he feels his way by new experiments, as, for example, when he shows that a mouse, in breathing, diminishes the volume of air like a burning candle, or that, when put in a glass vessel along with a lamp, it will not breathe much longer than half the time it would otherwise have lived. His views on respiration are quite correct; by way of the lungs "the aërial particles enter the mass of the blood and are there deprived of their nitro-aërial particles." The latter are indeed "the principal instruments of life and motion." He scoffs at the idea of a vital flame as a source of animal heat, accounting for the latter by "the nitro-aërial particles in the blood fermenting with its saline-sulphureous particles" (or, as we should say, by the oxidation of combustible material).

It was probably unfortunate that Mayow sought to explain by the aid of his nitro-aërial spirit the most diverse phenomena, such as the elasticity of solids, the nature of light and colours, of lightning and the transmission of nerve impulses, for in so doing the more important facts established were obscured in a haze of speculation which Mayow's early death prevented him from dispelling; thus it happened that exactly a century had to elapse before the work of Scheele, Priestley, and Lavoisier led to a re-discovery of principles already clearly enunciated as early as 1674.

W. A. D.

## TOWN GAS.

*Town Gas and its Uses for the Production of Light, Heat and Motive Power.* By W. H. Y. Webber. Pp. vii+275. (London: A. Constable and Co., Ltd., 1907.) Price 6*s*. net.

THE opening lines to the preface of this book supply the keynote to all that follows—"This book is a summary of what I know, that appears to me to be likely to interest a generally well-informed but not technically instructed reader about the manufacture of town gas and its uses."

The author, who was for many years the subeditor of the chief organ of the gas industry, has brought to bear his wide knowledge and ripe experience of the subject, and has given us a book that will be welcomed by all consumers of gas who desire an insight into the mysteries of its manufacture, and the best way to consume it for either heat, light, or power. The term "town gas" is used in preference to coal gas in order to cover the admixture of carburetted water gas and coal gas now so often distributed as a town supply, and which was necessitated chiefly by the demand for high candle-power gas, whilst now that the incandescent mantle has rendered rich gas not only unnecessary but wasteful, it is to be sincerely hoped in the interests of the consumer that carburetted water gas will disappear, and that only unadulterated coal gas will again become the general supply.

Excellent as is the book as a whole, there are many points that invite criticism; it was to be expected that the author would be an ardent champion of the virtues of coal gas, but surely when (pp. 175, 176) he is comparing the relative cost of coal and gas as a fuel for domestic use, and debits the cost of coal with a servant's wages and keep at 4*l*. a month, so bringing the cost of the coal as a fuel to 5*l*. 15*s*. a ton, he is going too far, and is more likely to do his cause harm than good. Burnt in properly constructed gas stoves, so arranged that none of the products of combustion find their way into the air of the room, coal gas is an ideal fuel, and, taking into consideration the cleanliness, saving in labour, convenience, and the fact that it need only be used when wanted, it can be shown to be equal in cost at 2*s*. 6*d*. per 1000 cubic feet to coal at 24*s*. per ton, but beyond this its most ardent advocate would scarcely venture to go.

Again, in speaking of the smoke curse and its prevention, he says (p. 227), "Gas is the sole practicable cure for this crying evil"—a statement which would not be endorsed by the advocates of smokeless fuels, such an anthracite, coke, coalite, or its imitations.

Some small inaccuracies might with advantage be corrected in a future edition; for instance, no gas manager would be inclined to accept as an average example of the normal supply to "the British Metropolitan region" a gas containing 15·52 per cent. of carbon monoxide, 1·5 per cent. of carbon dioxide, and 5·31 per cent. of nitrogen (p. 5).

On p. 69 the author speaks of blue water gas being made by the "methane-hydrogen plant"; this form of apparatus, however, should be deleted from amongst the "blue" gas plants, as its value is dependent upon

its producing a gaseous mixture in which methane plays an important part.

The chapters upon gas lighting and the arrangement of light for indoor and outdoor illumination are excellent, whilst the chapter upon the legal relations of gas suppliers, consumers, and the public should prove of the greatest value to those who desire to gain an insight into the intricacies of gas legislature.

## OUR BOOK SHELF.

*The Canterbury Puzzles and other Curious Problems.* By H. E. Dudeney. Pp. xxiii+195. (London: W. Heinemann, 1907.) Price 3*s.* 6*d.*

THE author of this little book is a well-known expert in the invention and solution of puzzles. Those which he presents to the reader are in the main entirely original; those which are not so are given in a new dress. Puzzles can be made, as the author says, out of almost any materials, and most people are familiar with specimens made out of matches, cards, coins, &c. Generally speaking, they are in essence either of an arithmetical or geometrical character, and involve, consciously or unconsciously, mathematical processes. An inferior class it is difficult to deal with except by some tentative process which involves no clear line of reasoning; such, for instance, are certain dissection problems which are of the nature of "patience," and are not good exercises for the intellect. Mr. Dudeney may be congratulated on having excluded these from his book.

It is no easy matter to invent a good puzzle; the simplest method would be to modify or generalise a known one; a really new idea is not likely to come from anyone who has not considerable knowledge and power of observation. The author gives shortly the solutions of the puzzles without, in the large majority of cases, explaining them. He recognises that the non-scientific solver is generally satisfied with knowing the solution, and is not curious about reasons; at the same time, he has known how to whet the appetite of more intelligent and curious persons for a knowledge of the principles which underlie the solutions. As an example may be noted the puzzle called "Lady Isabel's Casket." The square top of a box was inlaid with a rectangular strip of gold 10 inches by $\frac{1}{4}$ inch, and for the rest with square pieces of wood, no two of which were of the same size. The puzzle is to find out the size of the top of the box from these data. In his solution of this difficult question, Mr. Dudeney gives you the pattern, and states that the number, size, and order of the squares can be calculated direct from the given dimensions of the strip of gold, and that there is only one possible solution. He then leaves the mathematical reader with an interesting if difficult nut to crack.

The book is written in a popular manner, and is copiously illustrated so as to impart as much human interest as possible into the various questions. The puzzles are of great variety, and will be found interesting and alluring to persons of all kinds.

*Matter and Intellect: A Reconciliation of Science and the Bible.* By Andrew Allan. Pp. vi+224. (London: A. Owen and Co., n.d.) Price 5*s.*

THIS book has value from one point of view only; it is a series of unscientific statements of the very first water. "Now if we suppose that the oceans of the earth are represented by the bright sides of the discs of the radiometer, and the continents by the dark sides, we can understand how the sun attracts the water and repels the land, thus causing the earth to rotate upon its axis." Even Mr. Allan's more specific attempts to "reconcile Science and the Bible" will provide the average reader with amusement more often than they will scandalise him. "The serpent which tempted Eve was probably a dinosaurian, and may possibly have been the Iguanodon, a reptile which 'must have walked temporarily or permanently upon its hind legs,' thus presenting a human appearance, to which its magnificent skin or robe of feathers would add considerable beauty. Eve, therefore, seeing this human-like animal eating of the tree, and suffering no harm, would readily forget the prohibition, and be tempted to try the fruit for herself without any actual speech passing between the two."

Only one serious comment suggests itself when one's capacity for laughter is exhausted. This extraordinary work comes from a writer who has ability enough often to express himself clearly and forcibly, and quotes constantly from the pages of our more august popularisers of science. The schoolmaster admits at least a partial responsibility for the examination blunder. Is the blame here to be thrown entirely upon the pupil?

*Leçons sur la Viscosité des Liquides et des Gaz.* By Marcel Brillouin. Part i., Generalités. Viscosité des Liquides. Pp. vii+228. Part ii., Viscosité des Gaz. Caractères généraux des Théories moléculaires. Pp. 141. (Paris: Gauthier-Villars, 1907.) Price 9 francs and 5 francs.

BOTH the mathematical and experimental study of viscosity are admittedly of a high order of difficulty, and the author is to be congratulated on the clear and concise manner in which he has developed his subject. After summarising in the first chapter the early work on viscosity, the mathematical treatment of the subject is fully developed in the following four chapters. The second part of the first volume is devoted to a description of experimental work. Each of the principal memoirs is described and subjected to a careful criticism; this part of the book is very complete, and is absolutely free from the tendency to ignore work done outside France occasionally met with in French standard works.

In the second part the theoretical and experimental study are taken together, the relations between the viscosity and the dynamical theory of gases being fully discussed. The concluding chapters contain a general discussion of the molecular theories of liquids and gases.

The work as a whole is characterised by clear exposition, acuteness and fairness of criticism, and completeness. It will doubtless take its place as the standard work on viscosity.

*Aphorisms and Reflections.* From the works of T. H. Huxley; selected by Henrietta A. Huxley. Pp. vii+200. (London: Macmillan and Co., Ltd., 1907.) Price 2*s.* 6*d.* net.

To quote one of these aphorisms, "Time, whose tooth gnaws away everything else, is powerless against truth." There is garnered in Huxley's works so much truth worth wide dissemination that we echo heartily Mrs. Huxley's wish that this book will attract the attention of many persons who are yet unacquainted with her husband's writings. We trust also that this attractive volume, which can be carried in the pocket, will serve to make men of science and students turn oftener to the complete works of this master of lucid expression, who proved conclusively by his essays that it is possible to describe scientific achievements in a manner which will appeal to earnest readers of all classes.

## LETTERS TO THE EDITOR.

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

### The Inheritance of "Acquired" Characters.

DR. BASTIAN is unaccountably mistaken. Nothing in my letter indicates that I "assume (in the face of multitudinous difficulties) that the germ cells of all human beings are potentially alike." I have no doubt that germ cells differ, and therefore that the individuals which arise from them would vary even were they reared under absolutely identical conditions. These germinal differences between individuals and species are rightly termed innate. Individuals differ also because they are exposed to unlike influences during development. These differences, due to the unequal play of stimuli, are rightly termed acquired. But in my letter I did not allude to differences between individuals, nor even to acquired differences between one side of the body and the other. I merely discussed the question whether the terms "innate" and "acquired" correctly distinguished between certain *classes* of characters. I gave reasons for believing that a nose is no more innate and inheritable than a scar on it. If Dr. Bastian thinks I am in error, will he indicate in what sense the scar *is* less inborn and more acquired than the nose?

Often we are able to express our meanings very well by inaccurate terms the use of which has been sanctioned by convention. If, then, by "innate" and "inheritable" we merely imply characters which arise under the stimulus of nutriment no great harm is done. But, unfortunately, the words are usually given their literal meanings. The nose is supposed to be more rooted in the germ-plasm, more a product of evolution, more truly inborn than the scar; use acquirements are treated as trivial accidents unworthy the attention of the student of evolution; as a result, a very important phase of evolution is obscured and the study of it neglected. Dr. Bastian treats as absurd the belief that the bulk of human development after birth is an "acquirement." But, suppose we supplied an infant with sufficient nutriment but denied its body the stimulus of use and its mind the stimulus of experience, what sort of physical and mental maturity would the individual achieve? Would he develop nearly as well as the fœtus in the uterus or the butterfly in the chrysalis? How many of his physical and mental parts would attain even the stage of development reached in a little child? Apart, however, from the precise degree in which the human being develops under the influence of use and experience, the points I wish to urge are:—(1) that a principal phase of the evolution of the higher animals is the evolution of a power of responding by growth to these stimuli; (2) that the characters which thus arise are in some species (*e.g.* man) of great magnitude; and (3) that they are just as much a part of "normal" development as the inborn traits. Variation renders a species adaptable. But the power of developing under the stimulus of experience confers adaptability on the individual as well. In his very interesting letter, Mr. A. Bacot refers to the "repertoire" patterns of "the peppered moth" (NATURE, January 30). Consider how many repertoire patterns are possessed by the human being, whom the environment may train to play the part of an acrobat or a clerk, a beggar or a king.

Dr. Bastian insists that "post-natal growth is essentially due to the same causes as pre-natal growth." His words sound well, but what do they imply in this connection—that use plays nearly as important a part in pre-natal as in post-natal development?

He declares that the memories of Chinese and Mohammedan children are exceptionally good, and accounts for this circumstance by the hypothesis that the memory (the *faculty* of learning as distinguished from the things that are learnt which are only the *contents* of the memory) grows in the individual with use, and that this acquirement is transmitted. Animals which are not protected and trained by their parents have little or no memory. It would be of small use to them, for they must begin life fully equipped for the struggle by instinct. But in proportion as they are protected and trained, they are mentally immature on entrance into the world. The function of parental protection is to afford time and opportunity to make the acquirements without which they cannot attain maturity, and which in them in some measure take the place of instincts. The helplessness of the human being at birth, and the prolonged training necessary before he is able to maintain independent existence, is connected with the magnitude of his memory and the acquirements he makes by means of it. Now what is the evidence that memory (the faculty, not the contents) grows with use? So far as I am able to judge, memory, like the homologous power of growing physically, is greatest just when it is most useful—in the little child who has to equip himself with absolutely essential acquirements, and who, starting from a position of blank ignorance and incapacity, in a few months reduces the chaos of his world to order, and within two years even learns to walk and speak a language, as well as a vast deal more. Has Dr. Bastian any evidence that Chinese and Mohammedan adults are able to learn chapters of the Bible and the Koran more readily than their children? If, then, as seems probable, memory does not grow with use, how can the transmission of acquirements cause an increase of this faculty in a race?

Southsea, February 9. G. ARCHDALL REID.

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MR. BACOT'S interesting letter (p. 294) on melanism in moths suggests that the moth I had seen in Yorkshire (though I knew it appeared elsewhere) has a "repertoire" of colours as an actor has a repertoire of plays, and each moth in his time plays many parts. But the actor learnt them all, and the moth apparently inherits them all, the result being the same, since each possesses them all, and according to environment each appears occasionally "in yellow stockings and cross-gartered," or "in customary suits of solemn black," so that while the actor's knowledge of Hamlet dies with him, the moth's repertoire is perpetuated by an ineradicable involution. The question that lies behind all this does not seem to be answered by reference to the operation of evolution in a "previous epoch," for evolution begs the question. If we say that evolution in the past packed the "germ plasm" with possibilities, and evolution in the present only unpacks here and there one as it is required, we seem to be illogical in the use of any argument founded upon such an uncertain term, for the evolution of an actor and the evolution of a moth are two totally and impossibly different things, yet the stimulus of environment produces the same results.

If we believe that the racial moth has plastic possibilities he may start with whatever form or colour you like, and he will, when it is good for him, become "peppered," and will continue peppered until it is bad for him, when he will become black or otherwise. But if he has to carry a whole load of inherent characters all the time, where, when, and how did his germ plasm "acquire" them? Is what was possible in the past impossible now? And, further, does not the geological statute of limitations forbid the possibility of "cramming" every plant and animal with all these inherent characters during the short time that most species exist?

Dr. Archdall Reid in his most thoughtful letter sends a breath of delightfully fresh air into the subject, for he suggests that, after all, the arguments on both sides of this fascinating subject are not about facts, but words, and suggests (p. 293) that "confusion, misunderstanding, and futile controversy" are due in this matter to the "use of inaccurate terms." The idea of his letter suggests the possibility of a complete explanation of this puzzling question.

If natural selection operated in the past by the slow development of racial possibilities until a fixed type was reached, and if "recapitulation" is established, the "adult" form at any stage short of the last must have had, like the imperfect individual, the power of somehow acquiring characters that it then passed on to its descendants; and if this be so it is difficult to believe that acquired characters are no longer transmitted, for in that

case no new type can possibly arise, and every plant and animal in the world is an "end group," which is utterly inconceivable from the evolutionary hypothesis.

Sunlight is pure and colourless. Under the stimulus of a prism it becomes red, yellow, and blue. If animal form and colour are no more than the prismatic separation of inherent characters preexisting in the germ plasm, it seems to me that the theory of "Darwinian" evolution falls to the ground, and that it is not logical to use arguments founded on that hypothesis to establish conclusions that are fatal to its existence; but I write with a certain trepidation, remembering the fate of the earthenware pipkin that ventured into the stream amongst the iron pots. E. C. SPICER.

Waterstock, Oxford, February 1.

THE slightly dogmatic tone of my original article (January 2, p. 193) under the above heading has called forth quite a number of confessions of failure to understand the modern attitude towards this question. But, though we admire the generous spirit of those who have come forward and made a public exhibition of this failure, we consider that we have contributed our fair share by enticing them out into the open, and that they are asking too much when they try to relieve their very natural embarrassment by appealing to us to tell them what the modern attitude really is.

Ideally, of course, those who by inclination or accident are in touch with recent thought on these subjects ought to be only too glad to impart what they know to others less fortunate—to the aged and to the remote. But practically it cannot be done. The Editor of NATURE would say, perfectly rightly, that the correspondence column of his journal was not the place for enlightening those who fail to keep abreast of modern biological thought.

Dr. Archdall Reid's statement of the real nature of the problem is not a final one of course (as he probably thinks it is), but it is undoubtedly an improvement on the chestnut-old one which asserts that acquired characters are inherited as well as innate ones—a statement which is meaningless, because all characters are both acquired and innate.

If Dr. Bastian and Mr. Spicer have read that part of Dr. Reid's book, "The Principles of Heredity," which deals with this subject, their letters show that they have been unable to understand it. If they have not, it does not seem to us to be profitable to discuss the matter until they have. A. D. D.

## Atmospheric Electricity and Fog.

IN view of the interest recently shown in the subject of the dispersion or prevention of fog, it may be opportune to direct attention to a recent remarkable example of an atmospheric electricity phenomenon which usually accompanies London fogs. I should first explain that the method adopted at Kew for determining the absolute value of the potential gradient—*i.e.* the increase in the voltage per metre of height above the ground—certainly does not err in the direction of overestimating it. Taking eight years, 1898 to 1904, I found in a recent paper[1] that the mean value of the potential gradient at Kew was 159, the mean value for January being 201. The phenomenon referred to above is the occurrence during fog of specially high positive potentials, values double or treble that appropriate to the season being not unusual. At such times, however, there are usually large and frequent oscillations in the value of the gradient, so that the maintenance of an exceptionally high value for a number of consecutive hours is comparatively rare. On the morning, however, of January 21, during an intensely thick fog, the potential gradient at Kew exceeded 730 *continuously* from 1 to 9.30 a.m. How much it may have exceeded this value it is impossible to say, as the trace was beyond the limits of registration during the whole of this time. Both before the trace left the sheet and after its return the oscillations in the potential gradient were large, so that the maximum value was probably at least 1000.

A question of practical interest is whether the steepness of the potential gradient near the ground during fogs serves, or may be made to serve, a useful purpose in helping to clear the atmosphere of dust and smoke. It would also be interesting to know whether these high potentials are wholly without physiological effects on the human body. CHARLES CHREE.

National Physical Laboratory, February 5.

[1] Phil. Trans., A, vol. ccvi., p. 299.

## The Penetrating Radiation.

MANY writers apparently assume that the penetrating radiation is due to $\gamma$-like rays coming from radio-active products in the ground, and is practically constant in amount. It seems probable, however, that the penetrating radiation comes largely from radio-active products in the air, and that it fluctuates greatly in value.

Taking the mean value found by Strutt and Eve for the radium content of sedimentary rocks as $0{\cdot}9(10)^{-12}$ grams of radium per gram of rock, one finds that it is the source of $\gamma$ radiation which would produce an ionisation on the surface of the ground in air of less than 0·8 ion per c.c. per sec. Now the above value for the radium content is perhaps large for surface soils subject to constant erosion. The actual value found by Cooke for the ionisation in air as due to the penetrating radiation was 4·5 ions per c.c. per sec. McClennan takes the value as 9, and the writer has found a much larger value in the open country during the warm hours of the day. Assuming that the emanation of the radium differs from a depth of 50 cm. or 60 cm. of the ground, one gets a penetrating radiation that will produce a much greater ionisation.

If the penetrating radiation is due to radio-active products in the air, one would expect that it would vary very greatly in amount. The experiments of Jaffe, Campbell, Wood, Borgmann, the writer, and others would indicate this. On the other hand, if the penetrating radiation comes from radio-active products in the ground, its amount should be quite constant. Dike has found that the active deposit which gathers on a charged wire exposed to the air varies greatly with the time of day. Eve, by his charcoal method, has found widely different amounts of the radium emanation in the air at different times. The writer (*Science*, July 12, 1907) has found that during a heavy rain or snow the penetrating radiation decreases very greatly in amount. Rain and snow have been shown to carry down radio-active products, and if the penetrating radiation is due to radio-active products in the air, then its value should be less during a heavy rain or snow.

If the penetrating radiation is due largely to radio-active products in the air, its value in underground cavities should be less than on the surface of the ground. This is what Elster and Geitel found. The writer has found the ionisation in a closed electroscope to be approximately the same (*a*) in a cave; (*b*) in a cistern where there was 4 feet of water on all sides of the electroscope; and (*c*) inside a screen of lead and cast-iron blocks. In the open country during August and September (1907) this same electroscope showed an ionisation during the day some three or four times greater than during the night. In the cave and cistern the ionisation during the day and night was the same. It is natural to suppose that the penetrating radiation was greater during the day, and was due to radio-active products which had diffused out from the ground. During the night the ionisation was not much greater than for the electroscope in the cave or cistern.

Johns Hopkins University. W. W. STRONG.

## Classification of Secondary X-Radiators.

THE relation between the character of secondary X-radiation emitted by elements when subject to the same beam of X-rays and the atomic weight of the radiating substance has been considered in various papers, but only brief reference has been made to the dependence of the character of the secondary on that of the primary radiation. We have recently made a more systematic study of the relation between the secondary and primary rays.

Although the behaviour of no two substances is exactly the same under the same conditions, yet substances may conveniently be divided into several groups, each consisting of elements which emit a radiation possessing many properties characteristic of that group.

*H–S Group.*—The elements of this group when subject to a very soft X-radiation emit an almost perfectly scattered radiation of intensity proportional to the mass of radiating substance traversed by a beam of definite intensity.

This conclusion has been based on observations of absorbability, ionising power, polarisation, and distribution of intensity of the secondary rays.

With a moderately penetrating primary the scattering becomes less perfect—as shown by the above tests—and with a very penetrating primary beam there is considerable difference in character between the secondary and primary rays. This is not due to a superposition of a second radiation on the purely scattered; the purely scattered disappears, and in its place is a radiation more absorbable than the primary producing it, one which is less completely polarised, possesses greater ionising power, and is distributed in a way which exhibits less perfect control of the primary pulses over the radiating electrons.

*Cr–Zn Group.*—A striking characteristic of this group is the enormous ionisation produced by the secondary beams—of the order of 100 times that produced by an equal mass of one of the (H–S) group. This radiation, though produced by a heterogeneous primary, consists almost entirely of homogeneous rays of a very absorbable type. For certain primary beams there appears to be a more or less perfectly scattered radiation (producing 1 per cent. or 2 per cent. of the total ionisation) mixed with this.

Some remarkable properties of these homogeneous radiations have been referred to in a paper published by us. Their intensity is for large ranges in the penetrating power of the primary proportional to the ionisation produced by the primary beam in a thin film of air, so that it is highly probable that the radiation is produced during the process of ionisation in the radiating substance.

This radiation has not been found to disappear with any changes we have made in the primary beam.

*Ag–I Group.*—This group is characterised by its sensitiveness to changes in the character of the primary rays when they are of ordinary penetrating power. Though for moderately penetrating primary beams the secondary rays are heterogeneous and do not differ in penetrating power very considerably from the primary, they do not exhibit the polarisation effect and are not distributed in the manner showing scattering as exhibited by rays from the H–S group. These rays are not superposed on a radiation which could be classified with that from the H–S group. We have recently found, however, that some of the group (if not all) may be reduced to order by using a very easily absorbed primary. In this case there appears by every test made to be almost perfect scattering. The intensity, however, appears to be several times as great as that from an equal mass of a substance in the H–S group.

*W–Bi Group.*—These substances much more closely resemble the Cr–Zn group in the intensity and constancy in character of the rays they emit. They have, however, not yet been examined carefully.

Substances with atomic weights between those in the above-mentioned groups possess some of the characteristics of the two groups between which they lie. It appears possible that similarity in behaviour of all the different groups will be discovered by great variation in the penetrating power of the primary beams—one group when subject to a certain kind of primary beam behaving as another group when subject to a primary of different penetrating power.

The above grouping has, however, been based on the behaviour when subject to beams of ordinary penetrating powers, and the generalisations hold with very few exceptions.

C. G. BARKLA.
C. A. SADLER.

University of Liverpool, January 31.

## Auroral Characteristics of Clouds.

THE question has often been raised as to a possible connection between the aurora and the formation of clouds in the upper atmosphere. Observers in high latitudes have described cases in which, after a bright aurora, clouds have retained in some measure the forms of the previous light display. In other cases high clouds have been observed to arrange themselves in a formation very similar to the arch and streamers which are so characteristic of the aurora.

It may be of interest to those who have studied this question to record an exhibition of the latter kind which was observed here yesterday evening. During the greater part of the day the sky had been overcast with alto-stratus clouds, which, as usual, began to dissipate soon after sunset. Between ten and eleven o'clock (local time) the greater part of the sky was clear, but there remained in the south a mass of light cloud which formed an arch, from which bands spread out in all directions as if radiating from a point on the horizon under the middle of the arch. The effect was remarkably like an aurora except that there was no rapid motion of the bands or streamers. So far as I could judge from the Pole Star, the centre of the arch was due south, and its top about 5° above the horizon, but being on the river at the time in a native boat I had no means of making accurate measurements. Small masses of cloud in other parts of the sky exhibited wave lines, but they did not appear to be parallel to the main streamers, nor did the latter look like a wave formation. In about half an hour the outlines had lost their sharpness, and the whole effect became that of a light, diffuse mass of cloud.

The interest in this observation is two-fold. Those who hold that the clouds which take upon themselves the form of the aurora are due to the same causes as the aurora will be interested to know that this formation can be seen within 16° of the equator, and also that the centre of the arch appeared to be due south. Those, on the other hand, who hold that there is no connection between the two phenomena will feel their position strengthened in that an almost exact imitation of the aurora has been seen in the clouds in a region which is supposed to be almost entirely free from the aurora, thus lending support to the idea that such a formation is only one of the infinite number of possible cloud formations.

GEORGE C. SIMPSON.

Moulmein, Burma, January 13.

## Reissner's Fibre in the Frog.

IN October last, at the suggestion of Prof. Dendy, I undertook an investigation into the structure known as Reissner's fibre, which, Sargent's work notwithstanding, is still regarded by many as an artifact or as a coagulum of cerebro-spinal fluid, Johnston even, in his recent work on the "Nervous System of Vertebrates," dismissing the subject with the briefest of notices.

As a more than ordinary interest attaches to the description of any hitherto unrecorded feature in such a well-known type as the frog (*R. temporaria*), I venture to direct the attention of anatomists and physiologists to the fact that this animal possesses a well-developed and easily demonstrable Reissner's fibre, although no reference to this structure can be found in Gaupp's exhaustive treatise, nor does Sargent include any Anuran form in the long list given by him of animals in which he has seen the fibre.

The whole or parts of the central nervous system of about a dozen frogs have been sectionised, the sections having been cut in the usual three planes, and the fibre has been found in all the series examined, showing very definite and constant relations to the various brain structures. In every case it may be made out, beginning anteriorly at the dorsal end of the deep and narrow ependymal groove on the anterior face of the posterior commissure, and, emerging from this groove ventral the commissure, lying freely in the iter spanning the cavity between posterior commissure and cerebellum. It is somewhat closely applied to the ventral surface of the cerebellum, but posteriorly it slopes steeply towards the floor of the fourth ventricle and continues backward, with a wavy course throughout its length, to the hind end of the spinal cord near the floor of the canal.

Beneath the posterior commissure, in one specimen at least, it may be observed dividing into two or more finer fibres, while in the posterior half of its length numerous fine fibre-like structures may be made out, apparently given off to enter the substance of the spinal cord (much as Sargent has described for other forms), but that these

are truly given off by the fibre, and are not merely coagula, I have not yet been able to determine.

In transverse sections a definite sheath to the fibre can be seen, although the fibre itself is not readily made out in these sections until a certain familiarity with its course has first been obtained from an examination of sagittal sections. In the one fibre measured, the diameter was a little more than 6 $\mu$.

I did not find in any of my preparations that the fibre curled up into the "tangle" or "snarl" as described by Sanders in Myxine, by Dendy in Geotria, and mentioned by Sargent as commonly occurring, but this may probably be attributed to the precaution that was taken in every case thoroughly to fix and harden the central nervous system before severing the spinal cord. (The brain and spinal cord of several of the smaller specimens were cut entire in sagittal sections.) In all cases the central nervous system was dissected out entire from the freshly killed animal, and, where practicable, under the actual preserving fluid. Zenker's fluid, which did not admit of this, gave less satisfactory results than Flemming's stronger fluid. The stain employed was a modification of Weigert's suggested by C. Judson Herrick.

I have compared the fibre seen in sections so prepared with that shown in sections of *Petromyzon fluviatilis* in the laboratory collection at King's College, and also with that shown in Prof. Dendy's Geotria sections, which were prepared by altogether different methods, and the comparison leaves no doubt in my mind that we have here to do with a perfectly normal structure, and one cannot but express wonder that an object so clearly defined should have for so long escaped notice in the frog.

GEORGE E. NICHOLLS.

King's College, London, February 6.

### Rhynchobdella aculeata in Ceylon.

IT seems worth while to make a special note of the occurrence of the above-named food-fish in the inland waters of Ceylon. Its near ally, *Mastacembelus armatus*, has long been known to occur here. The general Ceylonese term for fishes belonging to the family Rhynchobdellidæ, commonly known as "spined" or "thorny-backed eels," though not nearly related to the true eels, is "telliya," but the natives distinguish between the "Gang-telliya" (river-telliya), which is *Mastacembelus armatus*, and the "Batakola-telliya" (alluding to the lanceolate form of the body), which is *Rhynchobdella aculeata*. The latter is reputed to grow to a length of 15 inches, and I recently examined one of 12 inches. In the former, commoner species, the vertical fins are confluent and the dorsal spines are numerous (about thirty-eight); in the second species, which has not previously been recorded from Ceylon, the dorsal and anal fins are separated from the caudal by a notch above and below; the dorsal spines are less numerous (sixteen), and the long, fleshy snout, which gives these fishes such a remarkable, antiquated appearance, is transversely ribbed below. The identification is therefore not open to doubt.

The Rhynchobdellidæ, as a family, are "excellent as food," to quote the words of the late Dr. Francis Day, and the hitherto unsuspected presence of an important member of the family in Ceylon affords an illustration of the incompleteness of knowledge concerning the biological conditions of the local inland fisheries. The batakola-telliya is stated to be absent from Malabar, a peculiarity of distribution which ranges it roughly in the same category with *Channa orientalis*, *Polyacanthus signatus*, and perhaps a few other fresh-water fishes.

ARTHUR WILLEY.

Colombo Museum, January 20.

### Poseidonius on the Originator of the Theory of Atoms.

IN Strabo's "Geography," book xvi., chapter xi., § 24, in the description of Sidon, we find the following remark:—

"If we are to believe Poseidonius, the ancient opinion about atoms originated with Mochus, a native of Sidon, who lived before the Trojan times."

This tracing of the theory of atoms to an authority much more ancient than Democritus does not seem to be mentioned in any of the works on physics, but as it is from the usually accurate Strabo, and rests on the high authority of Poseidonius, it seems worthy of notice.

T. J. J. SEE.

Naval Observatory, Mare Island, California,
January 27.

## AGRICULTURAL AND HORTICULTURAL RESEARCH.[1]

NO better evidence can be adduced of the growing interest in agricultural education and research in this country than the support which has been given to them by the county councils of Surrey and Kent during the last few years. They have materially promoted the science of agriculture and horticulture by furnishing the necessary means for the annual publication of such valuable reports as the one which has recently been issued from the South-eastern Agricultural College at Wye, Kent.

FIG. 1.—Gooseberry shoot attacked by the American Gooseberry-mildew numerous dark scurfy patches of the spawn of the mildew can be seen on the stem.

The report gives the results of an immense amount of painstaking investigation, and the exhaustive way in which the subjects are treated will be appreciated when it is realised that a bulky volume of 438 pages has been produced by the combined labours of the various members of the staff. The work is well written, and the different subjects are presented with pleasing freshness. Altogether we feel that it will prove a veritable mine of immensely valuable information, enhanced in no small degree by some of the most beautiful half-tone illustrations which we have yet seen in a work of this kind.

[1] University of London. "The Journal of the South-eastern Agricultural College, Wye, Kent." No. 16. Pp. ix+428. (London and Ashford, Kent: Headley Brothers, 1907.) Price 6s.; for Residents in Kent and Surrey, 3s.

Apart from the research work connected with the college, we gather that an increasing use is made of this institute "as an advisory centre on matters relating to agriculture and horticulture, so much so that in future years each department of the work of the college will have its special journal." In the section devoted to the report of the economic zoologist, Mr. F. V. Theobald, no less than 119 pests are dealt with, chiefly under the following heads:—those injurious to man's domestic animals, to fruit trees, to pulse, hops, and vegetables, flowers, forest trees, food-stuffs, and those causing annoyance to man; and beside these are some replies to Extra-British inquiries. One of the more interesting portions, issued from this department, is that dealing with the habits of the woolly aphis (*Schizoneura lanigera*). The author has conclusively proved that the damage done by the root form of this pest is much more severe in this country than has been generally supposed. In view of this, Mr. Theobald attributes the failures in treatment because we have hitherto ignored the presence of the migrating ground form. An injection of carbon bisulphide is recommended for the terrestrial, and a caustic alkali wash for the arboreal form. In a short note on the habits of the house fly (*Musca domestica*), this insect is said to "have bred largely in rotting cow-dung mixed with vegetable matter." We may add, however, that in one of our largest cities, stable middens and ash-pits form the chief breeding places for this fly; anything in the form of decayed vegetable matter, such as the dung of pet animals, vegetables, or even paper, provides food for the larvæ, and more especially so where heat is engendered.

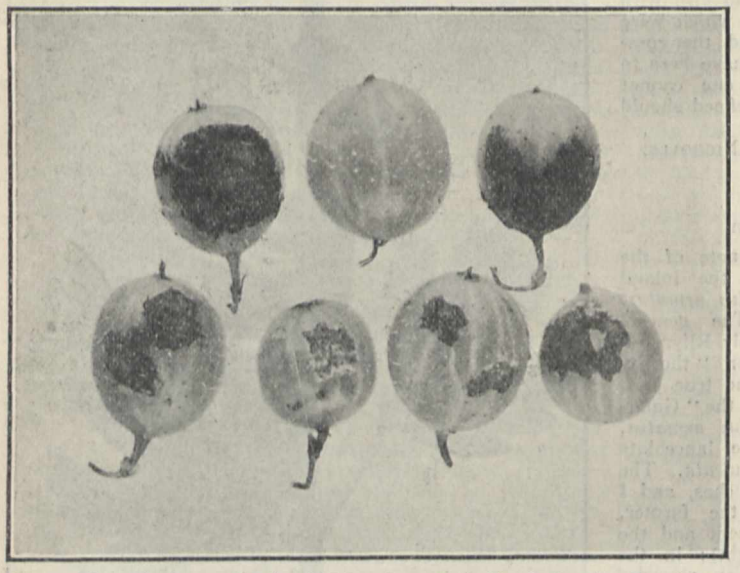


FIG. 2.—Six nearly ripe gooseberries which have been attacked by the American Gooseberry-mildew; one healthy berry is shown. (From Ireland.)

Messrs. H. E. Annett, F. V. Darbishire, and E. Russell furnish the report, from the analytical laboratory, in which it is stated that 250 samples of various substances were sent in for analysis during the past year. A detailed account is given of some of these; others are dealt with briefly. They are treated under the following heads:—Manures, feeding-stuffs, poisons, milks, waters and soils.

The reports from the botanical department are contributed by the four members of the staff. Mr. E. S. Salmon, the mycologist, has given evidence of his energy in turning his extensive knowledge of fungi to practical account for the benefit of fruit growers in this country. The detection of the outbreaks of American gooseberry mildew (*Sphaerotheca mors-uvae*) (Figs. 1 and 2) by him was followed by an energetic and tactful campaign to bring about the stamping out of the disease, and his efforts have been rewarded by the introduction of the Bill dealing with fungus attacks into the House of Lords. The Board of Agriculture and Fisheries has now made an order which may be cited as the Gloucestershire and Worcestershire (Gooseberry Mildew) Order of 1907. It came into operation on July 22. This constitutes the first legislative measure against fungus diseases put into force in this country. The fungoid disease of the gooseberry was discovered in the winter of 1906 in some commercial plantations in Worcestershire and Gloucestershire, but it had previously been introduced into Ireland on diseased stock imported from America. It is during the so-called "summer stage" that this mildew spreads most rapidly, as at this period the chains of Conidia are produced in continuous succession day and night. We gather that the cherry orchards in certain portions of Kent are still seriously affected by the fungus *Gnomonia erythrostoma*, which depends "absolutely for the continuance of its existence on fresh infection taking place in spring by means of the spores scattered from the fruit-conceptacles of the fungus on the dead leaves hanging on the tree." R. N.

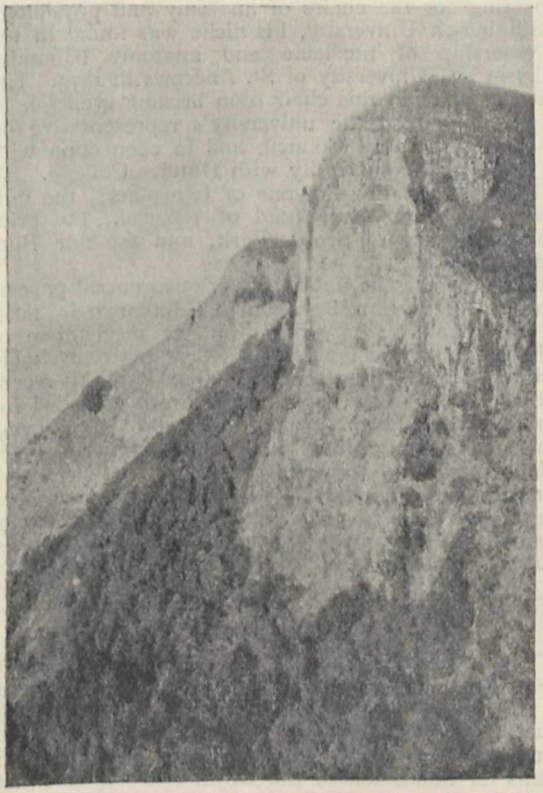
## THE GEOLOGY OF THE TRANSVAAL.[1]

THE most interesting features of the report of the Transvaal Geological Survey for the year 1906 are the excellent pieces of detailed mapping of the rocks of the Transvaal System, in the Lydenburg district, between Lydenburg and Belvedere, by Mr. A. L. Hall, and in the area immediately east of the Crocodile River and south of the Rooiberg by Mr. W. A. Humphrey. These two districts form parts of the same great synclinal trough; but while the Lydenburg district is at the eastern end of the trough, and is as remarkable for the simplicity of its geological structure as it is famous for the grandeur of its scenery, the area mapped by Mr. Humphrey lies 200 miles to the west and nearer the centre of the trough, and is characterised by an exceptionally complicated structure. Surrounded by the much later Red Granite formation, the isolated inliers of the Transvaal System in the latter area owe their position to faulting and folding on a large scale, an adequate explanation of which can only be forthcoming when the area to the west is mapped in detail.

In both districts the three members of the Transvaal System are developed—namely, the Pretoria Series, the Dolomite, and the Black Reef Series. The quartzites of the Black Reef Series, which form the lowest division, attain to an unusual development in the northern part of the Lydenburg district, where they form the main portion of the great escarpment of the Drackensberg, and play a considerable *rôle* in determining the wild character of the scenery.

[1] Transvaal Mines Department: Report of the Geological Survey for the Year 1906. (Pretoria, 1907.) Price 7*s*. 6*d*.

"No mere description," says the author, "can convey an adequate idea of the grandeur of the country between Belvedere and Blyde River Poort, where this stream enters the granitic Low Veld area." The escarpment of the Drackensberg "here forms a fine semi-circular curve, cut into by a number of spruits which give rise to precipitous and densely wooded kloofs. Immediately below the edge of this escarpment runs a massive kranz of quartzite nearly 500 feet in thickness." About a thousand feet below lies the great plain of the Low Country, beyond which, on a clear day, the distant chain of the Lebombo Hills can be discerned. The dip of the Black Reef Series being to the west, the escarpment rises eastward until it culminates in two magnificent bluffs, 3500 feet higher than the Belvedere (see Fig.). North of Belvedere the greater thickness of the quartzites produces, under the profound erosive action of the



Portion of the Great Eastern Escarpment of the Drakensberg, S. of Belvedere, formed by the Black Reef Series.

larger rivers, even more striking scenic effects. Thus the Blyde River is mentioned as having carved out a cañon in the quartzites to a depth of more than 2000 feet.

The Dolomite, owing to its more homogeneous composition and consequent absence of marked horizontal features, is characterised by a different type of scenery. Its vertical jointing, however, gives rise to peculiarly pointed kopjes, recalling portions of the dolomite area in the Tyrol. Northward, from Pilgrim's Rest to Hermansburg, the Blyde River flows in a gorge formed by precipitous walls of dolomite. It then travels in a more open valley; but on leaving the Dolomite it cuts its bed down into the Black Reef quartzites by a succession of cataracts and waterfalls until, joining forces with the Treuer River and the Belvedere Creek, it forms the deep cañon mentioned above.

The Pretoria Series presents in the Lydenburg district no feature, either topographical or geological, of especial interest; the same succession of shales, quartzites, and intrusive sheets is met with as in the country further south. The only noteworthy point is the marked thinning out of the series which is observable to the north of Lydenburg. The middle member of the system—the Dolomite—undergoes no great change in thickness, although a thick bed of quartzite (the "Blyde Quartzites") makes its appearance for the first time in the middle of the series; but while the upper member—the Pretoria Series—becomes much attenuated, the lower member—the Black Reef Series—rapidly assumes greater and greater proportions as it is traced northwards. In the extreme eastern portions of the Rand basin, near Springs, the boreholes put down through the Karroo Coal-measures and the Dolomite, to cut the underlying Witwatersrand Beds, showed that the Black Reef Series was represented at the base of the Dolomite by a bed of hard quartzite only 20 feet in thickness (see Hatch, Trans. of the Geol. Soc. of S. Africa, vol. vii., 1904, p. 63). At the Devil's Kantoor, in the Barberton district, it is 110 feet thick; at Mac-Mac, 700 feet; at Belvedere, 1260 feet; while near the northern termination of the Drackensberg, at Marieps Kop, the series reaches 2550 feet. The horizontal distance across the syncline formed by the beds of the Transvaal System, under the Waterberg and Red Granite formations, from Springs to the Drackensberg escarpment, is only about 160 miles, so that the conditions of sedimentation must have changed rather rapidly, the cause of which is not explained.

It will be seen by the free use made of Boer topographical words in the sentence quoted above that the committee appointed by the British Association at its last meeting "to determine the precise significance of topographical and geological terms used locally in South Africa" should serve a useful purpose. The precise meaning of such words as *kranz, bult, vlei,* and *kloof* will not be known to the generality of English readers, although *kopje, veld,* and *spruit* may have been made familiar by the late war. The report is accompanied by excellent colour-printed maps, and illustrated by beautiful photographic reproductions; but, unfortunately, it lacks an index, and has not even a paged table of contents.

F. H. HATCH.

## *THE HISTORY OF ARITHMETICAL NOTATION.*

THE invention of the decimal notation, which involves the use of zero and the assignment of local value to digits, made such an immense alteration in the character of arithmetical calculations that it would be extremely interesting to know its origin. It became familiar in Europe mainly through Mohammedan sources; hence the term Arabic, as opposed to Roman notation. But the discovery of Sanskrit literature and of Indian works on mathematics led to the theory that the real inventors of the system were the Hindus. The object of Mr. Kaye, in the paper referred to below,[1] is to show that this conclusion has been based on insufficient evidence, and that the whole question requires further and more careful consideration, including a critical study of Indian texts, to avoid being misled by spurious documents. Mr. Kaye gives in the first place a series of arguments which go far to prove that there is no trustworthy evidence for the use of the new notation in India

[1] "Notes on Indian Mathematics.—Arithmetical Notation." By R. Kaye. (Journ. and Proc. As. Soc. of Bengal, new series, vol. iii., No. 7, 1907.)

before the ninth century A.D., and that, if a single inscription prove untrustworthy, we shall have to fix the tenth century as the earliest date attested. Another point on which there can be no doubt that he is right is that the Arabic epithet *hindashi*, applied to the decimal notation, certainly does not mean Indian, the word for which is *hindi*, and cannot be connected with *hindashi* by any regular Arabic method of word-formation; not to mention that *hindashi* usually means "geometrical," and was derived from a Persian word by the Arabic lexicographers themselves. There is no probability in favour of Colebrooke's conjecture that the Indian work translated by Alfarazi was entitled "Siddh'anta"; and it is clear enough that after Brahmagupta there was a decline in the study of mathematics in India.

As to Brahmagupta himself, Mr. Kaye points out that in his treatise, side by side with Hero's exact formula for the area of a triangle in terms of the sides, he gives the absurd rule that the product of half the base and half the sum of the other sides is the gross area of a triangle—a survival of a rough approximation similar to those used in Egypt more than two thousand years previously—and this without a word of warning as to when this method would give no approximation at all (though, of course, it should be remembered that in applying this rule, the side most unequal to the others would probably be taken as the "base"). Altogether Mr. Kaye's paper is well worth reading, although he refrains from advancing any definite conclusions of a positive character.

G. B. M.

## *PROF. J. B. PETTIGREW, F.R.S.*

BY the death of Prof. Pettigrew another gap has occurred in the able band who, in the last three or four years of the "'fifties" of last century, studied at Edinburgh University. Born in 1834 at Boxhill, in Lanarkshire, young Pettigrew attended first Airdrie Academy and then arts' and a few divinity classes in Glasgow University. Proceeding to the University of Edinburgh as a medical student in 1856, he was first brought into notice in the senior anatomy class of Prof. Goodsir, for by devoting himself to a research on the arrangement of the muscular fibres of the heart he, with 125 marvellous dissections and 120 ingenious drawings, carried off the gold medal. By and by he became president of the Royal Medical Society in Edinburgh, and gave the "Croonian" lecture on the arrangement of the muscular fibres of the heart (after rehearsing it to his fellows in Edinburgh) to the Royal Society of London. He also won the gold medal in the class of medical jurisprudence for an essay on the presumption of survivorship. Next he carried on a research on the cardiac nerves and their connections with the cerebro-spinal and sympathetic system, for which a gold medal was awarded on graduation day, 1861.

After a brief period of office as house-surgeon in Prof. Syme's wards in Edinburgh Infirmary, Pettigrew was appointed assistant curator (under Prof. Flower) in the museum of the Royal College of Surgeons, London. There his remarkable skill in dissection, his stimulating enthusiasm, and his fine preparations of the muscular coats of the stomach, bladder, and other viscera—which he rendered so visible by distending them with coloured plaster of Paris—made his period of office memorable. He also published at this time his memoirs on the arrangement of the muscular fibres of the heart and on the muscular fibres of the stomach and bladder in the Philosophical Transactions; and another memoir on the relations, structure, and functions of the valves of the vascular system in vertebrates (Trans. Roy. Soc. Edin.). He further entered into another field, viz. the mechanism of flight, first prominently brought out in his lecture on the subject at the Royal Institution. This was followed by his elaborate and finely illustrated memoir in the Linnean Transactions, and, in 1879, by his volume on animal locomotion in the International Series.

His health, however, broke down in 1868, and as total blindness was feared he had to relinquish his post at the museum of the Royal College of Surgeons in London and take rest. Improving in health, he, in 1869, accepted the post of curator of the museum of the Royal College of Surgeons in Edinburgh. He held also the offices of pathologist to the Royal Infirmary, lecturer on physiology to the Royal College of Surgeons in Edinburgh, &c. He published in 1874 a volume on the physiology of the circulation in plants, in the lower animals, and in man. Unsuccessfully competing for the chairs of anatomy and physiology in Edinburgh University, his niche was found in the professorship of medicine and anatomy (Chandos chair) at the University of St. Andrews in 1875. His period of office in this chair soon became eventful, as he was appointed the university's representative on the General Medical Council, and in connection with the union of the university with Dundee College. To his labours, and those of one or two others, the university owes the Berry fund of 100,000*l*., the principal's residence of Scores Park, and the fine Bute Medical Buildings.

In recent years he published various general papers, gave the "Harveian" oration in Edinburgh in 1889, and continued his researches on the mechanism of flight in his private laboratory, where his remarkable machine with its gigantic wings exhibited all his recent experiences. Failing health lately much curtailed his labours, yet, under great weakness, he bravely elaborated a large illustrated work embodying the various researches formerly alluded to and evidences of design in animals. Besides other honours, he received the Godard prize of the French Academy of Sciences, and was made a laureate of the Institute of France.

W. C. M.

## *W. A. SHENSTONE, F.R.S.*

"DISTINGUISHED for his skill as an experimenter, for his ability as a teacher, and for his zeal in the introduction of improved methods of teaching physical science as a branch of general education." Such was the statement of his qualifications for admission to the Royal Society, of which Shenstone became a Fellow in 1898. By his friends he will be remembered for his enthusiastic eagerness in the pursuit of science, by unselfish devotion to what he thought his duty, by his loyalty and good-fellowship, and by the indomitable cheerfulness with which he bore physical suffering.

I made his acquaintance in October, 1871, when, as one of the Bell scholars, Shenstone entered the laboratory of the Pharmaceutical Society in Bloomsbury Square, where I was then demonstrator. After my removal to Clifton College, and feeling the need of an assistant, I was led to think of the young student I had left behind. He accepted the proposal to live under my roof, and thus was laid the foundation of a friendship which persisted without a check to the end. In 1875 Shenstone left me on his appointment as science master at Taunton College, and after about two years removed to Exeter School to take up a similar appointment. Here he built and fitted up a school laboratory, which he described in NATURE (July 25, 1878), and which proved that, con-

trary to general belief, a place for teaching physical science practically was not necessarily a very costly affair. Shenstone while with me assisted in various lines of experimental research, and after leaving was good enough to return and devote a whole month of the summer holidays to work in the laboratory. In those days no science master who had ambition to be more than a teaching machine could refresh his own mind or take part in the advancement of his subject save at the sacrifice of recreation, health, and pocket; and the pity of it is that times are not greatly altered in this respect.

In 1880 Shenstone was appointed chief science master at Clifton, and, spite of heavy routine, he managed to carry out admirable and difficult work on ozone, and on the properties of certain highly purified substances, from which he drew the important conclusion that in certain cases two elements can unite together without the presence of that minute quantity of a third substance which had been supposed by some chemists to be invariably necessary.

Shenstone was a skilful glass-blower and an excellent popular lecturer. He was instrumental in introducing vitrified silica as a material for making tubes, flasks and other vessels for laboratory use which are now manufactured in a clear form by Messrs. Johnson and Matthey. The production of this material was described by Shenstone in a lecture at the Royal Institution in 1901.

He died on February 3, after a long illness, at Mullion, South Cornwall, aged fifty-eight; and there he lies in the old churchyard within sight of the Cornish sea, which he so much loved.

Shenstone married in 1883 Mildred, daughter of the late Rev. R. N. Durrant, of Wootton, Canterbury, who survives him, together with a son and daughter.

WILLIAM A. TILDEN.

## NOTES.

AT the annual general meeting of the Royal Astronomical Society to be held to-morrow (Friday) the president will deliver an address on presenting the gold medal of the society to Sir David Gill, K.C.B., F.R.S., to whom it has been awarded for his contributions to the astronomy of the southern hemisphere and his other astronomical work.

THE Dublin meeting of the British Association will be held on September 2–9 under the presidency of Mr. Francis Darwin, F.R.S. The sectional presidents are as follows:—A, Dr. W. N. Shaw, F.R.S.; B, Prof. F. S. Kipping, F.R.S.; C, Prof. J. Joly, F.R.S.; D, Dr. S. F. Harmer, F.R.S.; E, Major E. H. Hills, C.M.G.; F, Lord Brassey, K.C.B.; G, Mr. Dugald Clerk; H, Prof. W. Ridgeway; I, Dr. J. S. Haldane; K, Dr. F. F. Blackman, F.R.S.; L, Prof. L. C. Miall, F.R.S. There will also be a subsection of Section F, to be concerned with agriculture, and the chairman will be Sir Horace Plunkett, K.C.V.O., F.R.S. The first evening discourse will be delivered by Prof. H. H. Turner, F.R.S., on "Halley's Comet," and the second by Prof. W. M. Davis, of Harvard University, on "The Lessons of the Colorado Cañon."

THE death is announced, at the age of eighty-seven, of the Rev. F. Howlett, whose drawings and observations of sun-spots have appeared in various publications, and will be remembered by many students of solar physics.

THE thirty-fifth annual dinner of old students of the Royal School of Mines will be held on Wednesday, March 18, at the Hotel Cecil. The chair will be taken by Dr. R. Pearce.

THE Mary Kingsley medal, which was struck by the Liverpool School of Tropical Medicine for presentation to distinguished investigators and others who have aided the cause of combating disease in the tropics, has been presented to Lord Lister, who formally opened the school on April 21, 1899. The medal was forwarded to Lord Lister with a letter signed by Princess Christian (hon. president), Sir Alfred Jones (chairman), Sir Rubert Boyce (dean), and Mr. Alan Milne (secretary), in which it was stated:—"No words of ours are required to amplify the esteem in which your magnificent achievements are held throughout the world. The Mary Kingsley memorial medal has been founded for the purpose of recognising the work of those who have accomplished much in the cause of tropical medicine. No one has accomplished more for this cause, or, indeed, for the whole cause of medicine, than yourself. The school feel honoured that your lordship has consented to receive the medal."

WE regret to learn from the *City Press* that Mr. R. J. Friswell, whose name is well known among analytical chemists, died on February 6 after a brief illness. Mr. Friswell studied at the Royal College of Chemistry under Sir Edward Frankland, and later acted as assistant at St. Mary's Hospital to Dr. W. J. Russell. Subsequently he engaged in research work at the Royal College, being appointed in that connection on the staff of the Indian Eclipse Expedition, and later, on his return to London, continuing to assist Sir Norman Lockyer in his spectroscopic researches. Afterwards, for many years, he was the chief chemist to the firm of Brooke, Simpson, and Spiller, leaving them to become the scientific adviser of the British Uralite Company, Ltd. For the last few years he had been in practice for himself as an analytical chemist in Great Tower Street. Mr. Friswell was elected a Fellow of the Chemical Society in 1871, and served on the council for several years; he was one of the founders of the Institute of Chemistry, and last year was chairman of the London section of the Society of Chemical Industry.

WE notice with regret the announcement that Sir J. D. Macdonald, K.C.B., F.R.S., retired Inspector-General of Hospitals and Fleets, died at Southall on February 7 in his eighty-first year. Sir J. D. Macdonald entered the Royal Navy as an assistant surgeon in 1849, and was placed in charge of the Plymouth Hospital Museum. In 1852 he joined H.M.S. *Herald*, and from that date until July, 1859, when promoted to surgeon, he was employed on surveying and exploring service in the south-west Pacific. After many years of almost unremitting microscopic work on the products of the sounding-lead, dredge, and towing-net, he was elected a Fellow of the Royal Society. His next promotion came in 1866, and for nine years he held the post of professor of naval hygiene at the Netley Medical School. In the meantime he was awarded the Macdougal-Brisbane medal of the Royal Society of Edinburgh in 1862, and the Gilbert Blane medal in 1871. He was the author of numerous papers read before the Royal Societies of London and Edinburgh and other societies. His published works also included "A Guide to the Microscopical Examination of Drinking Water," "Analogy of Sound and Colour," and "Outlines of Naval Hygiene." He was made a Deputy-Inspector-General of Hospitals and Fleets in February, 1875, and five years later was again promoted, holding from 1883 to 1886, when he retired from active service, the charge of the Naval Hospital at Stonehouse. In 1902 he was made a K.C.B.

THE February number of the *Strand Magazine* contains two articles of interest to readers of NATURE. In the one,

entitled "The Physiognomist at the Zoo," Mr. A. E. Johnson discourses pleasantly on the expression of animals as an indication of character, his points being brought out by four striking—if somewhat accentuated—portraits of the lynx, the chimpanzi, the mantled guereza monkey, and the loris. The second article, by Mr. D. M. Beddoe, is devoted to the recently discovered mummy believed to be that of Menephtah, the Pharaoh of the Exodus, and the son of the great Rameses. Photographs of the mummy illustrate the article, so that the reader may look on features familiar to Moses some three thousand or more years ago.

In the January number of the *Quarterly Journal of Microscopical Science* Mr. C. C. Dobell describes the life-history and development of a newly discovered genus and species of flagellate monad (*Copromonas subtilis*) inhabiting the fæces of frogs and toads. Starting with the adult monad, it appears that the organism undergoes two distinct phases or cycles of development, one asexual and the other sexual. In the former multiplication takes place by means of longitudinal division, with the eventual development of two flagellas and two nucleuses. In the sexual stage the monads conjugate in pairs, and thus eventually give rise to a dormant cyst, from which, when a suitable *nidus* is reached, a small hyaline monad is liberated, this in due course developing into an adult monad, when the whole cycle recommences. The cysts are swallowed by frogs or toads, and reach the rectum by the usual course.

The anatomy and histology of the alimentary tract of the dugong are described in detail by Mr. J. F. Gudernatsch in the fourth part of vol. xxxvii. of Gegenbaur's *Morphologisches Jahrbuch*. At the conclusion of the paper the author refers to some curious resemblances between the sirenian and the cetacean tongue. In that organ in the dolphin there have, for instance, been found certain peculiar pits occupying the position of the circumvallate papillæ in other mammals, while the author has discovered very similar pits in the dugong which occupy the position of the foliate papillæ. Whether these pits are connected with the sense of taste is, however, uncertain, although the occurrence in both cases of ganglionic cells in the pits is in favour of such a function. An important difference between the sirenian and cetacean mouth is the presence in the former of large salivary glands, which are totally wanting in the latter.

A series of "studies in adaptation" commences in the fifth volume of the *Baltimore Journal of Experimental Zoology* with an article by Dr. Alexander Petrunkevitch on the sense of sight in spiders, a subject discussed with great elaboration and in minute detail. This sense is of the greatest importance to certain species, those which obtain their prey by hunting depending entirely on sight during the chase. Nevertheless, the acuteness of vision even in the sharpest-eyed spiders is far inferior to that of man. An insect of about a square centimetre in size would, for example, be perfectly visible—even perhaps to the extent of specific recognition—to the human eye at the distance of a yard, whereas to a spider of the genus Phidippus it would appear as a tiny, ill-defined moving object, while to members of the genus Lycosa it would be invisible. The poor visual power of spiders is largely due to the peculiar form of the retina, while the inferiority in this respect of Lycosa to Phidippus depends on the fact that, while in the latter the retinal image covers the terminations of nearly seven nerve-rods, in the former it scarcely exceeds the diameter of a single rod.

The best mode of determining the age and rate of growth of eels forms the subject of a long article by Mr. K. J. Gemsöe in the report of the Danish Biological Station for 1906 (Copenhagen, 1908). By means of measurements, it has been ascertained that when eels attain a length of about 18 cm. and begin to develop scales, they have lived for two years in fresh water, that is to say, from the time of their arrival as larvæ or glass-eels. After this the age may be determined by the number of concentric zones or rings in the scales, which indicate annual periods of growth. The age of any individual eel is therefore the age of the scale +2. Judged by this test, it appears that in the case of males some assume the silvery breeding-dress (preparatory to descending to the ocean) in about 4½ years after their arrival in fresh water, although the majority do not do so until from 5½ years to 7½ years. The females, on the other hand, assume the silver livery somewhat later, scarcely ever before 6½ years, and in most cases not until 7½ years, while many do not do so until they are 8½ years old or even more, whereas only one male of that age was detected in the course of the experiments. It is during their fourth and fifth years that eels increase most rapidly in girth.

In an article on the evolution of life, published in the *Century Illustrated Magazine* for February, Dr. Percival Lowell asserts that life is an inevitable phase of planetary evolution, and consequently that every planet must be inhabited by living creatures of some kind during a certain stage of its existence. Mars is at present passing through this stage. The author also considers it demonstrated that in the case of our own planet life originated in the ocean. Very picturesquely does he describe the life of the deep sea. That a blind fauna, he writes, should inhabit the abyssal depths is of itself a sufficiently wonderful phenomenon; but that nature should undertake to light the region, and that by means of its inhabitants, is still more wonderful. And yet "this is precisely what she does, and with something akin to electricity, each animal carrying with it its own machine. Whole tracts are brilliantly lighted up, till they must resemble London or Paris by night, only that in these thoroughfares of the abysses of the sea the passers-by provide the illumination."

Prof. Dunbar, as the result of a series of experiments conducted over a long period and with every care, has come to the conclusion that the bacteria are not an independent group of organisms, but, together with some of the yeasts and moulds, are stages in the life-history of green algæ ("Die Entstehung von Bakterien, Hefen und Schimmelpilzen aus Algenzellen," published by R. Oldenbourg, Munich and Berlin). A pure culture of a single-celled alga belonging to the Palmellacia was obtained, but by modifying the culture medium by the addition of acid, alkali, or traces of copper salts, other organisms, generally bacteria, occasionally moulds and yeasts, and even spirochætes, made their appearance in the pure cultures. Granting there was no flaw in the experimental methods, and every care seems to have been taken to exclude contamination, the results are susceptible of another explanation, viz. that the secondary growths were derived by transformation of the algal cells, in fact, by the phenomenon of "heterogenesis," which has been claimed by Bastian to occur with certain organisms.

An editorial in the *Indian Forester* (November, 1907) on "Forestry and Agriculture," advocating the afforestation of some of the large areas of uncultivated or unculturable land in India, touches on a matter of great importance, seeing that so much timber is required as fuel.

It is suggested that the planting of such areas might be undertaken by district boards working in consultation with forest officers.

A PAMPHLET on the fibrous plants of the west coast of Africa, forming the subject of a paper read before the Liverpool Chamber of Commerce by Dr. E. Drabble, has been received from the Liverpool Institute of Commercial Research in the Tropics. The author treats his subject under the groups of leaf fibres, bast fibres, piassavas, and raffias. The first named include species of Agave, Sansevieria, and the oil palm Elæis; most of the bast fibres are derived from malvaceous plants; the greater quantity of both piassavas and raffias is obtained from the palm *Raphia vinifera*.

AN account of culture experiments undertaken with the object of studying the effect of organic matter on nitrification in impure cultures is contributed to the *Bulletin International de l'Académie des Sciences de Cracovie* (June, 1907) by Messrs. A. Karpinski and B. Niklewski. The authors come to the conclusion that weak solutions of various organic substances, especially humates, and to a less degree acetates, peptone, and sugar, do distinctly promote nitrification processes. Messrs. T. Kóźniewski and L. Marchlewski communicate a paper on chlorophyll derivates, in which they indicate the spectra obtained with solutions of phyllotaonin and allophyllotaonin.

THE first number of the *Kew Bulletin* for the current year contains diagnoses of new flowering plants, "Decades Kewenses: XLV., XLVI.," by workers in the herbarium, and identifications by Mr. G. Massee of a set of fungi collected in Singapore by Mr. H. N. Ridley. The majority of the fungi are agarics, of which several are new species; a Calodon (Hydnaceæ) and a Geoglossum also furnish new species. An article on the fruit fly, *Ceratitis capitata*, refers to a pest that has caused serious damage to orange bushes and fruit trees in South Australia and other colonies. It has also been reported from the neighbourhood of Paris on apricots and peaches. Kerosene placed in shallow vessels is said to provide an attractive lure that has proved efficacious. Mr. T. A. Sprague contributes a synopsis of the prickly fruited species of Euonymus, of which three are new Chinese plants, and an article by Mr. F. Turner on Australian grasses is reprinted.

THE first of a series of contributions by Mr. T. F. Cheeseman to a fuller knowledge of the flora of New Zealand, constituting an addendum to the author's "Manual," is published in the Transactions of the New Zealand Institute (vol. xxxix.). As a guide for future work, the author indicates the regions that have been insufficiently explored. The notes refer chiefly to new varieties and specimens. The indigenous localities of the handsome shrub *Clianthus puniceus* and the myrtaceous tree *Metrosideros tomentosa* are collated. Illustrations are given of two unique specimens of branched "nikau" palms, *Rhopalostylis sapida*, one showing seventeen irregular branches. Separate papers are devoted to the description of a plant previously named *Trithuria inconspicua*, now transferred to Hydatella, another genus of the same order, Centrolepidaceæ, and to the discussion of the discontinuous distribution of *Pittosporum obcordatum*.

LAND erosion by storm water appears to be going on at a remarkably rapid rate in parts of Cape Colony, and to cause considerable loss to farmers and others. For the past three years the Irrigation Department has been collecting information on its bad effects and on possible remedies, and this is now summarised in the November (1907) number of the *Agricultural Journal of the Cape of Good Hope*. It is considered that two main causes operate—the burning of forest, of bush, and of grass has destroyed vegetation that used to hold back storm water, and the movement of cattle and waggons, &c., along definite paths tends to wear down tracks in which the water can start its course. Once erosion begins its progress is very rapid. Among the instances quoted we may mention the Ongers or Brak River. Sixty years ago there was no river, but for some cause erosion began, and it has since gone on so rapidly that the river channel is now generally 300 feet wide and 15 feet deep. In order to check the process it is suggested that small channels or "sluits" should be so obstructed by stones, bushes, &c., that the water must distribute itself over a wider area, and do correspondingly less damage. The subject is a very important one, and we trust that the Irrigation Department will not stop at collecting information, but will proceed to a sound and complete investigation of the whole matter.

THE Bulletin of the American Geographical Society, vol. xxxix., No. 11, contains an account of physiographical experiments on the aggrading and degrading stream, carried out at the Ohio State University during the past year. An initial valley of cement was constructed in a water-tight tank, the slope of which could be varied. Fire-clay of unequal fineness was placed above the upper end of the valley, and a fine spray of water turned on. During the aggradation process, the construction of systematic asymmetrical fans over previous flood plain deposits, and the formation and preservation of pits or depressions on the flood plain, were noticed. The latter is the probable origin of the so-called "kettles" of the Susquehanna. Conclusions were also arrived at concerning the relative importance of slope, water supply, and load as causes of the aggradation or degradation of streams, the influence of load being specially emphasised. Finally, Prof. Davis's explanation of alluvial terraces standing above existing flood plains was strikingly confirmed by the action of the experimental river as it carved out its series of terraces.

AN account of the astronomical and geodetical observations made in 1902–5 by the German Commission for fixing the boundaries of German East Africa appears in *Die Mitteilungen aus den deutschen Schutzgebieten*, vol. xx., part iv. The report is published in three divisions, the first containing particulars of the Lake Kivu Expedition under Captain Herrmann, with Prof. Lamp as astronomer, and the second and third giving the results of the Deutsche Uganda Grenz Expedition under Captain Schlobach. On the Kivu Expedition, Prof. Lamp established an astronomical station at Usambara, and determined a value for its latitude. Valuable geodetical results, of which full tables are given, were also obtained in this neighbourhood, and with the figures of Captain Schlobach furnish the data for triangulation of a map of the district west and north of Lake Victoria. East of the lake, triangulation was continued from a base at Port Florence, the work being carried as far as Kilimanjaro, and from thence connected with Zanzibar. A map is published showing the boundary line between British Uganda and German East Africa from Lake Victoria to Kilimanjaro. Captain Herrmann also gives an account of altitude measurements made by the Kivu Expedition, and Captain Schlobach a table of those made during the Uganda Grenz Expedition.

THERE are few regions in the world so rich in minerals as the State of Nevada. In addition to gold, silver, copper and lead, deposits of sulphur, zinc, bismuth, antimony, tungsten, nickel, iron, mercury, arsenic, salt,

and gem-stones are being developed at the present time. The discovery of the great Tonopah gold mine in one of the barren mountains in the desert area of the State caused Nevada to awake from the economic lethargy into which she was plunged after the flooding of the Comstock mines in the early 'eighties, and the closing down of nearly every mine of importance on the other mining fields through the fall in the price of silver. In an interesting review of the recent mining developments in Nevada, Mr. A. Selwyn-Brown, in the *Engineering Magazine* (vol. xxxiv., No. 4), shows that since the Comstock rush in 1850 to the end of 1907 the gold and silver mines of the State yielded the enormous value of 206,670,000*l*. In the Journal of the Franklin Institute (vol. clxv., No. 1) Prof. O. C. S. Carter also deals with the mineral resources of Nevada, and describes the irrigation started by the Government Reclamation Service. The irrigation canal, thirty-one miles in length, to divert water from the Truckee River to the Carson River, together with 270 miles of lateral ditches, is completed, and is the first irrigation project carried out under the authority of the United States law of June 17, 1902.

In the December (1907) number of the *National Geographic Magazine*, the organ of the National Geographic Society of Washington, U.S.A., Mr. R. M. Brown describes an experiment intended to give practical proof of the curvature of the earth, carried out by him on Lake Quinsigamond, on the model of the well-known investigations of Mr. H. Yule Oldham on the Bedford Level in this country. The most interesting contribution is that of Hon. J. Wilson, Secretary of Agriculture, entitled "The Modern Alchemist," in which he surveys the multiform activity of his department in the introduction of new varieties of cereals and other useful plants, arboriculture, forestry, fisheries, and many other subjects.

Mr. F. Soddy is giving a course of six free public lectures at Glasgow University on "The Nature of Matter." He regards them as some slight return to the people of Glasgow for the help given to the University by prominent citizens, especially in the equipment of the department of physical chemistry with apparatus for research, and he believes it to be the duty of men of science who receive such help to place before the public from time to time, and in a manner to be readily comprehended, the principal results achieved. The first lecture, delivered on January 30, dealt with radium and atomic disintegration.

Sir Charles Todd has issued the meteorological observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the year 1905. The section relating to rainfall gives the monthly and yearly totals at 517 stations, and compares the figures with the average for previous years wherever there are at least seven years' records. The year was a moderately wet one over the older established agricultural districts, but dry over the pastoral country, the interior, and the Northern Territory. From August to the middle of December the weather was very cold in the southern areas; the special meteorological feature of the year was the exceptionally cold spring; February was also the coldest month on record. The useful experiments on the exposure of thermometers have been continued; Sir Charles Todd observes that, as might be expected, the thermometers in the "Stevenson" screens as a rule read higher than those on the "Greenwich" stand during the night and lower during the day; the difference depends very much on the wind-force and the state of the sky. An interesting table shows the approximate mean rainfall for each month and year from 1861 to 1905, and the average yield of wheat per acre; wheat-growing can be successfully prosecuted only where the percentage of winter rains is largely in excess of that for the summer months.

M. L. Natanson has an article on the electromagnetic theory of dispersion in gases in the April (1907) number of the *Bulletin de l'Académie des Sciences* of Cracow. After working out the general theory of propagation of electrical disturbances in a medium composed of molecules which contain electrons or "corpuscles" having their own periods of oscillation, he limits his consideration to gases, and assumes the molecules to contain electrons of one kind only. He finds that in the cases of hydrogen, oxygen, air, and carbon monoxide, the values of the refractive indices calculated on this assumption agree fairly with the values found by experiment. In the case of carbon dioxide the agreement is poor, owing probably to the influence of the absorption bands in the infra-red. In the case of sodium vapour the assumption of two kinds of electrons fails to produce a satisfactory agreement between theory and experiment.

Prof. Cohen has made valuable additions to our knowledge of the allotropic states of the elements, notably in the cases of tin and antimony, and the current number of the *Zeitschrift für physikalische Chemie* (January 31) contains two papers by him (in collaboration with Mr. J. Olie) on the so-called amorphous antimony and bismuth. These were described by Mr. F. Hérard in 1888 as resulting from the action of nitrogen upon these metals at a dull red heat. The experiments now described prove conclusively that neither pure antimony nor bismuth undergoes any change when heated in nitrogen which has been carefully purified from oxygen and oxides of nitrogen. If the nitrogen is not specially purified, however, Hérard's results are reproduced, the "amorphous" antimony (or bismuth) thus obtained consisting of a mixture of the metal and its oxide. These allotropic modifications of the two elements are therefore non-existent.

Under the title "A propos de l'État civil de Jean Baptiste van Helmont" the question of the correct dates of the birth and death of van Helmont is discussed by the Chevalier Edmond Marchal in a recent number of the Bulletin of the Royal Academy of Belgium (1907, No. 7, p. 732). The researches of M. G. Des Marez among the registers of the cathedral church of Ste. Gudule, Brussels, show that van Helmont was born, not in 1577, as has been generally supposed hitherto, but on January 21, 1579 (N.S.). The date of his death is somewhat less certain, being either November 16, 1635, or December 30, 1644; it appears to be clear, however, that he died in Brussels and not at Vilvorde, where he spent seven years of his life. It is an interesting fact that the bust of van Helmont at the Royal Belgian Academy of Medicine does not represent Jean Baptiste van Helmont at all, but his son François, whose likeness, appearing side by side with that of his father in the first edition of the "Ortus Medicinæ," was confused with it when the bust was carved in 1863.

Messrs. Longmans, Green and Co. have published a fifth edition of "The Old Riddle and the Newest Answer," by Father John Gerard, S.J. The price of the book is 6*d*.

The publishing firm of B. G. Teubner, Leipzig and Berlin, has just issued an authorised translation into German, by Dr. J. Friedel, of Prof. Horace Lamb's standard work on "Hydrodynamics." The second English edition was reviewed in Nature of November 21, 1895 (vol. liii., p. 49), and the third edition, carefully revised and largely

supplemented, was published early in 1906. This is the edition of which a translation has now appeared in Teubner's collection of text-books of mathematical science.

THE fifth volume of the second series of the Proceedings of the London Mathematical Society has now been published by Mr. Francis Hodgson. The volume includes an account of the meetings held during the session November, 1906, to June, 1907, and many of the papers read before the society during the session. Obituary notices are included of the late Colonel Mannheim and Dr. E. J. Routh. As the meetings of the society are recorded from time to time among our reports of societies and academies, it is unnecessary to do more now than mention the publication of the volume containing records of papers presented.

## OUR ASTRONOMICAL COLUMN.

OCCULTATIONS OF URANUS IN 1908.—From Dr. Downing we have received, as an excerpt from No. 2, vol. lxviii., of the Monthly Notices, a table showing the times and angles of immersion and emersion for the occultations of Uranus by the moon observable at British observatories during the present year. The places specifically named are Adelaide, Melbourne, Sydney, Wellington, Natal, Perth (W.A.), and the Cape, and the dates of the occultations are April 22, May 19, July 13, August 9, and October 3. Dr. Downing hopes that the publication of these data will enable astronomers favourably situated to observe some peculiarities in the appearance of the planet at the time of occultation.

OBSERVATIONS OF COMETS 1907*d* AND 1907*e*.—The results of the observations of comets 1907*d* and 1907*e*, made at the Vienna Observatory with the 6-inch refractor, are recorded by Dr. J. Holetschek in No. 4231 (p. 99, February 3) of the *Astronomische Nachrichten*. Some of them for 1907*d* are particularly interesting, as, in addition to the brightness of the nucleus and of the comet as a whole, the observer gives the length of tail and the times before sunrise up to which the comet was observable. Thus on July 18, when the brightness of the whole comet was of the fourth magnitude, the brightness of the nucleus being 7·5 mag., the object was followed until 15h. 33m. (Vienna M.T.), that is, until 46m. before sunrise. On August 26, mag. 2·0, it was seen until 20m. before sunrise. The greatest length of tail measured was about 8°, on August 18.

Signor Abetti also records, in the same journal, a number of observations, made at the Arcetri Observatory, of these two objects during November and December, 1907.

PLANETS NOW VISIBLE.—With Mercury at its greatest eastern elongation on February 13, it may be possible, during the next night or two, to observe, with the naked eye, five of the major planets at the same time. On February 13 Mercury will set about 1½ hours after the sun, *i.e.* at about 6.30 p.m., some 10° south of west. Venus is still quite a bright object in the western sky, whilst Saturn sets, nearly due west, some three hours after sunset. Mars does not set until about 10.30 p.m., and is to be found in the constellation Pisces to the south-east of the Great Square of Pegasus.

At 6 p.m. Jupiter is now a striking object in the eastern sky, having risen some three hours earlier.

Mercury will, of course, be the most difficult object to locate, but, following the directions given in these columns on December 5, 1907 (p. 115, vol. lxxvii.), Mr. W. E. Rolston found the planet at 6.35 a.m. on December 6, and was able to follow it easily until 7.10 a.m. The observation was made at Wimbledon Park, the sky being clear and the sun rising at 7.51 a.m.

At present Uranus is in conjunction, and therefore invisible, but Neptune may be found, with a telescope, situated between the stars $\epsilon$ and $\zeta$ and near to $\eta$ Geminorum.

ENCKE'S COMET, 1908*a*.—The following is a further extract from the ephemeris for Encke's comet given in No. 4222 (p. 363, December 18, 1907) of the *Astronomische Nachrichten* by M. Kamensky and Mdlle. Korolikov :—

*Ephemeris oh. (M.T. Berlin).*

| 1908 | α (app.) h. m. | δ (app.) ° ′ | 1908 | α (app.) h. m. | δ (app.) ° |
|---|---|---|---|---|---|
| Feb. 12 ... | 23 50·3 ... | +6 21·0 | Mar. 3 ... | 0 27·0 ... | +10 4·5 |
| ,, 20 ... | 0 3·9 ... | +7 43·7 | ,, 7 ... | 0 35·6 ... | +10 56·1 |
| ,, 28 ... | 0 18 9 ... | +9 15·3 | ,, 11 ... | 0 44·7 ... | +11 49·6 |

From this we see that the comet is apparently travelling in a north-easterly direction through the constellation Pisces, and should be sought, in the earlier part of the evening, some few degrees to the south of the Great Square of Pegasus. Its photographic magnitude on January 19 was 12·5, and its distance from both the sun and the earth is decreasing rapidly. According to Prof. Wolf's observations, the above ephemeris required corrections of +2·4m. and −24′ on December 25.

Some interesting notes on the successive reappearances of Encke's comet appear in No. 2 (February 1, p. 13) of the *Gazette astronomique*.

A CATALOGUE OF ZODIACAL STARS.—A catalogue of zodiacal stars, principally prepared for use in occultations of stars by the moon, appears as part iii., vol. viii., of the Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac. This catalogue was prepared by Mr. H. B. Hedrick, and all the catalogues employed in the investigation were reduced to the same absolute system as Prof. Newcomb's Catalogue of Fundamental Stars, which appeared as part ii. of the same volume. The catalogue includes 1607 stars, and gives the definitive positions for the epochs 1900·0 and 1920·0. Centennial and secular variations and proper motions are also given.

METEORS OBSERVED ON JANUARY 2.—Observing at Hjörring, North Jutland, Herren P. Muusmann and H. Wanning saw a number of meteors in the region between Cygnus and Pegasus on January 2. The observations were made between 8.10 and 8.20 p.m., and during the last five minutes more than thirty meteors were counted. The position of the radiant is given as 300° + 61° (*Astronomische Nachrichten*, No. 4230, p. 95, February 1).

## THE WINDS OF NORTHERN INDIA.[1]

THE phenomena of atmospheric motion may be considered and discussed from three main points of view. They may be (1) regarded in their relation to the general system of winds prevailing over a rotating earth unequally heated, and having an annual period of temperature variation; (2) considered in their dynamic relation to the synchronous distribution of the various other meteorological elements, more particularly the pressure and temperature, in their vicinity; (3) arranged in order to facilitate comparison with one another at different times and seasons, and to exhibit the connection between wind and climatic conditions in such a way as to enable account to be taken of this connection in a general survey of meteorological conditions and in relation to forecasts. In the memoir before us, the main feature is the development and discussion, from the third standpoint, of the results of anemographic records at Allahabad and Lucknow during the years 1890–1904 and 1878–1892 respectively. Sir John Eliot prefixes the discussion by a short account of the synchronous distribution of pressure and temperature at Lahore and Allahabad, which is very suggestive of the method to be adopted and the results to be used in a discussion from the second standpoint. The modifying influences of the orographic distribution are too considerable to admit of close connection between the results recorded and the general atmospheric circulation, and no attempt has been made to develop such connection.

[1] "Memoirs of the Indian Meteorological Department, being Occasional Discussions and Compilations of Meteorological Data relating to India and the Neighbouring Countries." Published under the direction of Dr. G. T. Walker, F.R.S. Vol. xviii., part iii. V. A Discussion of the Anemographic Observations recorded at Allahabad from September, 1890, to August, 1904. VI. A Discussion of the Anemographic Observations recorded at Lucknow from June, 1878, to October, 1892. By Sir John Eliot, K.C.I.E., F.R.S. (London: Harrison and Sons, 1907.) Price 2 rupees.

Allahabad is situated about 300 feet above sea-level at the junction of the Ganges and Jumna, where their general direction is changing from E.S.E. to E. The plain of these rivers forms part of a great plain 1300 miles long and about 200 miles broad, in no part of which does the height above sea-level exceed 1000 feet. On the north it is bounded by the Himalayas, which change their direction from N.W. to W. in passing from the Punjab to Assam. Near Allahabad the direction is approximately W.N.W.

To the south the ground rises gradually to the plateau of Central India, across which runs a low range of hills from Bombay in an E.N.E. direction, passing about 150 miles south of Allahabad.

Allahabad is therefore near to the south edge of the flat bottom of a trough with sides converging towards the east, the south side being very slightly inclined and of small elevation compared with the north. Lucknow is 110 miles N.W. of Allahabad, and lies at the centre of the flat bottom. The motion of the air in such a trough is complicated, but the general result is that air flowing in or out transversely is deflected towards the right in its course, the effect being in both cases to produce motion parallel to the trough. On these motions will be superposed the effect of the general circulation of the atmosphere, which is both actually and theoretically westerly in the upper regions so long as the trough is definitely north of the thermal equator, becoming easterly when the thermal equatorial region includes the trough.

The exposure of the anemometer at Allahabad was excellent, but at Lucknow was not so good, and at the latter place the instrument, during the later years, was not kept in proper working order. It is probably partly due to these causes that the records from Lucknow show winds considerably weaker than those from Allahabad.

The results of the records have been arranged in tables giving for each month for each hourly interval of the day (1) the mean movement of the air, irrespective of direction; (2) the number of winds recorded under each octant of the compass; (3) the number of miles recorded under each octant of the compass; (4) the mean coordinates of the resultant wind movement.

For exhibiting the leading features of the air movement these results have been charted, and a series of carefully drawn plates is given at the end of the discussion. In addition to wind roses, showing the amount of wind in each direction and the proportion of calms, there is an excellent set of diagrams showing for each month of the year the diurnal variation of the air movement and the mean monthly resultant velocity. The diurnal variation bears no direct relation to the ordinary diurnal pressure variation.

For the purposes of discussion, Sir John Eliot divides the year into two periods, the dry season extending from the middle of October to the middle of June, and the wet season during the remaining four months. The dry season is further subdivided into the dry cool season, November to February, and the dry hot season, March, April, May.

During the cool season, pressure gradients are small, and the main feature of the distribution is the persistent continental high pressure. Locally, the isobar through Allahabad at 8 a.m. in January runs nearly through Lucknow in a N.W. direction, becoming more northerly as the day advances, while the wind changes its direction from W.N.W. to N.N.W. Thus there appears to be a correspondence between the wind direction and the local pressure gradients similar to that noted every day on the synchronous weather charts for temperate latitudes. The variations are, however, too rapid for the development of the full effect of the earth's rotation in producing an approach to parallelism between the isobars and the wind direction.

It is important in considering this rotation effect to remember that it acts as a modifying influence in conjunction with the pressure distribution, and although the latter is in the end the outcome of the air motion and temperature variation, there is nothing to warrant the assumption that the combined effect on air motion is to produce always a veering in the wind. Air starting from rest and moving across a permanent system of isobars will veer as it progresses, but a change in the direction of the gradient may more than counteract this action of the earth's rotation.

Briefly, if the pressure fall in unit distance along two perpendicular straight lines, $Ox$, $Oy$, by amounts $\alpha$, $\beta$, and if the resultant velocity due to the effects of the pressure gradient, friction, and the earth's rotation be proportional to the gradient and make a constant angle $\theta$ with the isobars, the components of velocity in the two directions $Ox$, $Oy$, will be $k(\alpha\cos\theta-\beta\sin\theta)$, $-k(\alpha\sin\theta+\beta\cos\theta)$.

If, now, $\bar{\alpha}$, $\bar{\beta}$ are the mean values of $\alpha$, $\beta$ deduced from mean pressure distribution, and if $\bar{u}$, $\bar{v}$ are the mean values of the components of wind velocity, we find

$$\bar{u}=k(\bar{\alpha}\cos\theta-\bar{\beta}\sin\theta),\quad \bar{v}=-k(\bar{\alpha}\sin\theta+\bar{\beta}\cos\theta),$$

and the same relation, therefore, holds for mean values as for synchronous distributions. The angle $\theta$ depends on friction and on the time the motion has been in progress; $\bar{u}$ and $\bar{v}$ will therefore vary between limits depending on these factors. The general relation is, however, simple, and it appears desirable to test its applicability to motion in the large unbroken plain, ample and suitable data for which are furnished by the present series of memoirs.

An examination of the diagrams shows that at both Allahabad and Lucknow the cold season has the greatest percentage of calms and the smallest air movements. The latter are, however, steadier than at any other season. Calms are $2\frac{1}{2}$ times more frequent at Lucknow than at Allahabad, the average number at the former place being 30 per cent. of the total number of observations. The mean direction of the air movement is slightly W. of N.W. at both places. The diurnal variations of magnitude are similar at both places, the maximum being reached about 3 p.m., when the average velocity is more than double that of the evening. The changes in direction at the two places are very different. The wind usually veers throughout the day at Allahabad, and backs during the night; at Lucknow the main feature is considerable, backing from 11 a.m. to 3 p.m., and slow veering for the remainder of the day, with slight and very irregular movements at night, the changes being much less than those at Allahabad.

In the dry season the winds are of maximum intensity at Lucknow and of mean intensity at Allahabad. At both places the actual resultant air movement is a maximum for the year. The winds are relatively very steady in March and April, and very unsteady in May. The mean direction changes from N.W. to N. at Allahabad, and from W.N.W. to N.W. at Lucknow during the course of the season. The diurnal changes are similar to those of the cold season, but are more marked, and in May the changes in direction are greater at Lucknow than at Allahabad, but still take place in the reverse direction.

The winds during the wet season are remarkable for their increased variability in direction. The actual amplitude of the diurnal variation of magnitude is considerably less than for the dry season, the winds being less feeble during the night and of average intensity in the day. At Allahabad the mean direction of air movement in July is from W.S.W., but during the early morning hours it is nearly S., and at 4 p.m. it is N.W. by N. At Lucknow the mean direction is N.E., and the variations are less marked, but there is a very remarkable change from E. by N. to N.E. by N. between 10 a.m. and 11 a.m. The motion is the same as if the places were in a trough of ascending motion the axis of which moved towards Allahabad in the course of the day.

Diagrams are also drawn to show the variations of air movement along, and perpendicular to, the axis of the trough, appropriately called the axial and transverse variations. The axial variation shows similar features throughout the dry season. There is a fairly rapid increase in the daytime until 4 p.m., after which there is a rapid decrease. During the night there is practically no change. In the wet season the increase is much smaller at both places. At Allahabad the maximum is reached at 11 a.m., and the decrease takes place slowly during the remainder of the day. There is a feeble secondary maximum at 2 a.m. At Lucknow the increase takes place slowly and irregularly from midnight to midday, while there is a similar decrease until 10 p.m. The transverse variation is throughout markedly different at the two

stations. At Allahabad the northerly component *diminishes* during the dry season until midday, after which it increases until about 5 p.m., the epochs advancing two hours from November to April. At Lucknow the northerly component *increases* rapidly to a maximum at 11 a.m., and diminishes again to a minimum at 3 p.m., after which the changes are slow and irregular.

In the wet season there is an average increase in the northerly component at Allahabad from midnight until 4 p.m., and a corresponding decrease for the rest of the day. At Lucknow the main feature is a sudden increase in the northerly component between 10 a.m. and 11 a.m., after which there is a decrease with oscillations to the minimum at 10 a.m. on the following day, the rapid afternoon fall being absent.

These features of the transverse oscillation, together with the greater steadiness of the winds at Lucknow, appear to be partly due to its more central situation; but the backing of the wind during the day indicates that a longer period is necessary to produce the larger motion in the direction of the trough than is requisite for the smaller transverse variation. It is probable that for Allahabad the earlier transverse motion is modified by the effect of the Central Plateau; this effect diminishes in the afternoon, and is replaced by the influence of the Himalayas, which is, of course, weaker than at Lucknow. The nature of the transverse variation appears also to imply that the effect of the Himalaya range in constraining the air motion in the plain is actually produced dynamically through the medium of rotary motion transverse to itself rather than through a forcing of the stream lines to conform to parallelism with a rigid boundary.

The solution of the problems presented, and their connection with convective motion not shown directly by the winds, would be considerably advanced by a knowledge of the vertical temperature gradient in the free atmosphere over the plain.

A noteworthy feature is brought out in the auxiliary tables, representing the steadiness of the wind by the ratio of the resultant air movement to the total movement. The winds of the wet season are most steady near midnight, while in the dry season the epoch of maximum steadiness is about 4 p.m.

The accompanying tables exhibit the main features of the annual variation and the distribution of the wind.

| | | Lucknow | | | | | | | | | Allahabad | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Season | Month | Percentage amount of wind to total amount in each month from | | | | | | | | Monthly percentage of wind | Percentage amount of wind to total amount in each month from | | | | | | | | Monthly percentage of wind |
| | | N. | N.E. | E. | S.E. | S. | S.W. | W. | N.W. | | N. | N.E. | E. | S.E. | S. | S.W. | W. | N.W. | |
| Dry | October | 26·0 | 9·2 | 6·5 | 1·9 | 1·2 | 6·2 | 18·1 | 30·9 | 5·3 | 13·9 | 14·7 | 13·0 | 6·5 | 3·5 | 7·8 | 21·6 | 19·0 | 5·7 |
| | Nov. .. | 30·3 | 8·2 | 1·9 | 1·7 | 0·9 | 5·5 | 21·3 | 30·2 | 3·9 | 15·2 | 11·0 | 10·6 | 6·4 | 2·7 | 5·1 | 25·7 | 23·4 | 4·3 |
| | Dec. ... | 22 5 | 7·7 | 3·3 | 2·1 | 1·8 | 13·2 | 27·6 | 21·8 | 4·8 | 10·4 | 8 9 | 7·5 | 4·2 | 3·4 | 7·4 | 34·0 | 24·2 | 5 6 |
| | January | 19·0 | 7·3 | 6 9 | 3·6 | 2·8 | 10·6 | 25·5 | 24·3 | 6·3 | 8·8 | 11·8 | 15 0 | 3·9 | 2·2 | 8·2 | 32·2 | 17·9 | 6·9 |
| | February | 22·4 | 7·3 | 4·1 | 2 6 | 1·9 | 8·4 | 25·7 | 27·6 | 8·4 | 7·2 | 10·4 | 11·8 | 6·4 | 2·8 | 8·0 | 33·0 | 20·4 | 7·2 |
| | March... | 16·3 | 5·9 | 3·3 | 4·1 | 3·5 | 11·6 | 30·8 | 24·5 | 11·6 | 10·4 | 13·6 | 6·7 | 3·3 | 2·3 | 6·4 | 34·6 | 22·8 | 9·4 |
| | April ... | 16·8 | 9·1 | 4·2 | 2·0 | 3·9 | 10·8 | 26·0 | 27·2 | 12·1 | 12·7 | 14·4 | 6·9 | 4·6 | 5·3 | 7·9 | 28·0 | 20·2 | 9·1 |
| | May ... | 12·6 | 10·2 | 15·7 | 6·0 | 4·1 | 9·0 | 22·2 | 20·2 | 11·1 | 15·0 | 16·2 | 16·5 | 8·2 | 5·0 | 4·6 | 16·4 | 18·2 | 10·8 |
| Wet | June ... | 13·9 | 14·0 | 20·3 | 7·2 | 5·5 | 9·4 | 14·6 | 15·1 | 11·2 | 9·1 | 18·2 | 21·5 | 9·1 | 7·1 | 9·3 | 14·6 | 11·1 | 11·8 |
| | July ... | 16·5 | 14·4 | 22·0 | 9·7 | 7·3 | 11·2 | 9·7 | 9·2 | 9·9 | 7·6 | 12·8 | 16·5 | 7·5 | 11·7 | 14·2 | 18·5 | 11·2 | 10·8 |
| | August | 18·3 | 13·0 | 19·5 | 7·8 | 7·5 | 11·1 | 10·6 | 12·2 | 7·5 | 8·4 | 16·3 | 18·3 | 7·8 | 5·8 | 12·0 | 20·7 | 10·7 | 10·1 |
| | Sept. ... | 17·4 | 15·8 | 16 6 | 6·3 | 3·0 | 7·3 | 15·6 | 18·0 | 7·9 | 10·9 | 17·5 | 17·5 | 8·9 | 4·6 | 11·4 | 18·7 | 10·5 | 8·3 |
| | Year ... | 18·0 | 10·4 | 11·2 | 4·9 | 4·0 | 9·8 | 20·7 | 21·0 | 100 | 10·6 | 14·3 | 14·2 | 6·6 | 5·2 | 8·8 | 23·8 | 16·5 | 100 |

We note that the winds were taken from the records of Beckley's anemograph, but there appears to be no statement regarding the factor used in the reduction to miles per hour. In any case, the winds are comparatively feeble, the maximum recorded in any single hour being thirty-five miles at Lucknow and forty-five miles at Allahabad. There appears to be an inconsistency between the statement on p. 320 of the years of maximum and minimum movement and the table on the preceding page, so that either the suggestion of periodicity or the table needs readjustment.

The arrangement of the memoir is excellent, and it is full of suggestiveness to the student of meteorology. It forms a valuable contribution to our knowledge of Indian meteorology. E. G.

## *MEDICAL INSPECTION IN LONDON.*[1]

DR. JAMES KERR, medical officer (education) to the London County Council, here adds another to the series of his admirable reports. These always contain much that cannot be neglected by the students of educational conditions, and this report is no exception. It consists of sixty-six pages crowded with new materials of the highest scientific and practical value. Administratively, probably the most important statement in the report is that "a point has now been reached, as to whether the greater part of the medical inspection shall remain fruitless, or whether the Council shall take steps which will justify its later interference to see that its younger dependents have a fair chance of benefiting properly by the education offered. Treatment as a public concern will have to be considered in respect to certain educational matters, such as visual troubles, discharging ears, ringworm, and the care of the teeth, in which neither the private practitioner nor the hospitals can give hope of either providing sufficient or satisfactory relief for most of the cases requiring it" (p. 3). A composite committee has been appointed to inquire into this serious problem, on which the circular recently issued by the Board of Education has a definite bearing. The report of this committee will be looked for with interest alike by the hospitals and the practitioners.

The general results of the medical inspection confirm the work of previous years. The medical officers are now coming to closer quarters with the children, and this report contains many careful pieces of special research. These it is here possible only to indicate. Emphasis is laid on the urgency of the inspection of infants, especially of infants of three to five years of age. Tubercular bone and joint disease can then be most readily prevented. In inspection of the secondary schools and training colleges there was noticed a "general ignorance of how to expand the thorax by deep inspiration" (p. 8). Among girls, "headaches were complained of by 20·5 per cent. . . . Exaggerated movements, corrugated foreheads, insomnia, and somnambulism were met with. Several cases of overstrain were specially reported" (p. 9). "The average standard of physique is low." There is a careful mathe-

[1] London County Council. Report of the Education Committee of the London County Council submitting the Report of the Medical Officer (Education) for the year ended March 31, 1907.

matical study (pp. 10–16) by Dr. Shrubsall of the statistics of growth. The general results might with advantage have been further elaborated on the practical side. As to teeth, there is a strong plea for school dental clinics on the model of Strassburg.

A special investigation as to tuberculosis of the lungs in school children was undertaken by Dr. Squire and Dr. Annie Gowdey. Of actual phthisis, only 335 cases (*i.e.* 0·55 per cent.) were found among 58,934 children. The sections on hearing and acuity of vision contain much fresh material. One of the most important sections deals with the "development of articulatory capacity for consonantal sounds" (p. 27). Considerable detail is given of the methods of testing, and 105,000 tests were made on some 3000 children. The results are given in an exact quantitative way, capable of analytical study. This department is of immense importance to the teacher, as the work already done in phonetics has abundantly shown. As to fatigue, some new curves from rifle-shooting are given. It is found that the curve improves with a little practice, co-ordination improving very rapidly. Cigarette-smoking was found to impair the capacity to shoot straight.

There are the usual sections dealing with the inspection of defective children and cripples, country homes, infectious diseases, adenoids, &c.; but two sections must be specially named, one on the artificial lighting of school-rooms and the other on the mental and physical effects of bad ventilation. In both researches the practical results are very definite, and ought to be driven home among teachers and architects alike. Of the ventilation research, some provisional conclusions are:—"Temperatures above 65° F. give rise to definite subjective symptoms, slackness and inattention in some, headaches in others. Although it is not easy to assert definite mental alteration till about 70° F." "Symptoms do not appear at 65° if the air is kept in gentle movement by a fan in the room. With temperatures 70° F. and above, other factors being normal, there are marked symptoms and very evident deterioration in mental alertness and accuracy." At low temperatures, relative humidity does not affect the mental capacity of children, but increase of humidity increases the effects of high temperatures. Carbonic acid gas in considerable excess increases markedly the fatigue of the children. Exact details are given of the methods used.

The London County Council is to be congratulated on the issue of this mass of original and important observations in so many departments of medical inspection. Dr. Kerr's reports show the great educational possibilities of the system, which, under his guidance, has revealed many new regions for clinical and scientific research.

## *THEORY OF THE MIRAGE.*

THE theory of the mirage forms the subject of several recent papers by Prof. Antonio Garbasso. In notes contributed to the *Atti dei Lincei*, xvi. (2), 1, 8, the author discusses the propagation of light in a heterogeneous medium, making use of the principle of least time, and considering the case of space of any number of dimensions defined by curvilinear coordinates. The space in question is supposed to be subject to the usual assumption that the square of the line-element is a homogeneous quadratic function of the differentials of the coordinates. As might be expected from the principle of least action (an analogy the applications of which to the problem are probably already known), the equations of the path can be reduced to the form of the ordinary equations of dynamics by a suitable choice of the characteristic function. The applications to the mirage itself are discussed in a paper in the *Memorie* of the Turin Academy, 1907. Prof. Garbasso claims that while the phenomenon has been studied both experimentally and theoretically, his present work fills a gap in the literature by establishing agreement of a quantitative character between the results of calculation and those of experiment.

Two kinds of mirage are distinguished, one due to the variations of density caused by diffusion between two fluids of different refrangibility initially having a plane of separation; this is called the mirage of Vince. The second kind, called the mirage of Monge, depends on diffusion outwards from a plane boundary maintained indefinitely at the same conditions. The former condition gives three images, two direct and one inverted; the latter gives only the reflected image. Prof. Garbasso calculates the law of density from the equations of diffusion, and thus determines the equations of the trajectories of the rays of light and the form of the wave-front.

The final comparison with experiment is discussed in a paper by Luigi Rolla, also in the *Memorie* of the Turin Academy. In it the last-named author describes experiments showing how, not only has Wollaston's original artificial mirage of the Vince type been reproduced with its three images, but also the Monge mirage has been imitated, and in both cases the trajectories of the rays have been determined by observation and compared with results of theory. Moreover, a mirage with five images, observed by Parnell at Folkestone in 1869, was realised by placing over a layer of carbon bisulphide a mixture of equal parts by volume of alcohol and chloroform. Owing to the unequal rates of diffusion, the conditions give rise to five images, and this and other experiments are shown to be suitable for lecture-room demonstration.

By taking a block of gelatin containing a cavity filled with liquid which gradually diffuses into the gelatin, the corresponding images for a cylindrical or spherical distribution of density have been also produced and compared with the results of mathematical calculation.

The first and second figures show the mirages of a diaphragm somewhat in the shape of a ship produced by the medium formed by diffusion between alcohol and

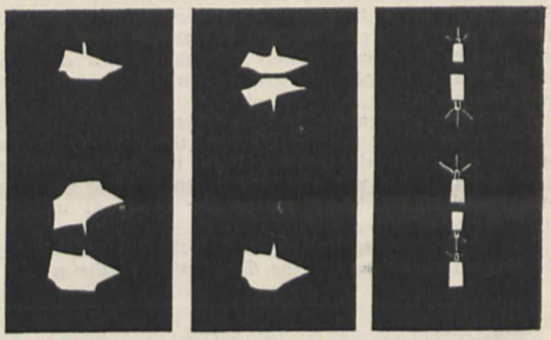


FIG. 1. FIG. 2. FIG. 3.

bisulphide of carbon. Fig. 1 represents the appearance after a few hours, Fig. 2 after several days. Fig. 3 shows the five images obtained by diffusion between bisulphide of carbon and a mixture of alcohol and chloroform.

G. H. B.

## *A CONTRIBUTION TO THE HISTORY OF IRONCLADS.*

LORD ROSSE has made an interesting contribution to the history of ironclads by placing at the service of the Institution of Naval Architects copies of letters written by his father to various distinguished men in the years 1854–5. From these letters it appears that the late Lord Rosse not merely appreciated the importance of armour protection against horizontal shell fire, but satisfied himself that it was possible by means of suitable proportions to secure ample stability in ironclad ships. Naval officers were then disposed to think that the "top-weight" inevitable with heavy loads of armour would make vessels unstable. Lord Rosse proposed the construction of ironclad floating batteries of moderate size; they were intended to fight in smooth water, and consequently were to carry their guns at a small height above water. The exposed sides were to be armoured with 5 inches of iron, and the upper decks to be covered with 2-inch plating.

In a letter to Sir John Burgoyne dated June 26, 1854, Lord Rosse proposed an armament of sixteen heavy guns; the draught of water was not to exceed 12 feet to 13 feet, and the vessel was estimated to be about 1500 tons. He

added :—"All this is the roughest possible, but I think if worked out in detail the result would not be widely different. The greatest care would, of course, be necessary to guard against submarine explosives." To this letter Sir John Burgoyne replied that he doubted whether 5 inches of iron would answer its intended purpose and make a vessel practically impregnable. In this connection he remarked :—"Iron is very treacherous, and breaks, rends, and tears under very irregular effort. The Navy have a thorough dislike to it for the sides of ships, but then they have never contemplated, I believe, such thickness."

These remarks from so high an authority on ordnance as Sir John Burgoyne throw an interesting light upon opinions prevailing little more than fifty years ago in regard to naval construction. Lord Rosse was not discouraged, but proceeded to press his scheme upon the attention of the Duke of Newcastle and on Sir Baldwin Walker, who was then Controller of the Navy. In his letter to the Duke of Newcastle, Lord Rosse stated that he "had been considering, *no doubt in common with many others*, in what way the great mechanical resources of England could be brought to bear against the mechanical resources of St. Petersburg." In thus writing, Lord Rosse no doubt had in view the fact that ironclad floating batteries had been decided upon. Five such vessels were commenced in France in September, 1854, and later on similar vessels were built here, but not from Lord Rosse's outline design.

In the publication of these letters a filial duty has been fulfilled. The late Lord Rosse is shown to have been one of the first to make a definite proposal for the construction of ironclad floating batteries, and his treatment of the subject is worthy of his scientific reputation. On the other hand, it cannot be doubted that the action taken in France was independent of the suggestions of the late Lord Rosse. The correspondence with Sir John Burgoyne, the Duke of Newcastle and others could not have been known to the Emperor Napoleon when he took action; the construction of the French floating batteries was commenced about the same time as these letters were written, but was preceded by experimental trials made to determine the thickness of the armour to be adopted. It may be added that General Paixhans, to whom the introduction of horizontal shell-fire was due, had proposed the use of armour protection for ships about 1820, and Mr. Stevens began the construction of a floating battery near New York many years before the Crimean War took place. Lord Rosse obviously had no knowledge of these facts when he made the proposals above described, and acted quite independently.

## THE SMITHSONIAN INSTITUTION.

THE report of the secretary of the Smithsonian Institution for the year ending June 30, 1907, has been received. It serves admirably to show the great part taken by the institution in American scientific life. Full particulars are provided, not only of the explorations and researches inaugurated by the institution, but also of the work of the U.S. National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park, the Astrophysical Observatory, the Regional Bureau of the International Catalogue of Scientific Literature, and the excavations on the Casa Grande Reservation—all placed by Congress under the direction of the institution.

Reference has already been made from time to time in these pages to the researches prosecuted in connection with the institution, but it will be of interest to refer to a few which are summarised in the report. In connection with the study of the older sedimentary rocks of North America, on which Dr. Charles D. Walcott, the secretary of the institution, has been engaged during the past twenty years, upwards of 20,000 feet of strata have been carefully examined and measured. The Cambrian section has been found to include more than 12,000 feet of sandstones, shales, and limestones, and the Lower, Middle, and Upper Cambrian have been found represented in the section of Bow River series and the Castle Mountain group. Characteristic fossils have been found in each division.

An expedition in April, 1907, to Alaska to collect the remains of large extinct vertebrates, particularly mammals, has already done good work. Dr. G. P. Merrill has examined the crater-form depression near Canyon Diablo, Arizona, to determine whether it was caused by explosive volcanic action or is due to the impact of a mass of meteoric iron; his observations are being collated and arranged.

In connection with the seismological investigations undertaken to compare the disturbance in Chile with that in California, it seems to have been determined that there has been some elevation of the coast of Chile, but no traces of a rift such as caused the earthquake at San Francisco. Numerous other researches were assisted during the year; these included the absolute measure of sound, the properties of matter at very low temperatures, the study of the upper air, the organs of flight, and others.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The council of the Senate recommends that the necessary steps be taken for altering Statute B, chapter vi., by the insertion of a paragraph giving the University power, upon the retirement of a professor, either at the date of his retirement or subsequently, to appoint him as a professor emeritus in the subject of the professorship previously held by him. A professor emeritus shall not as such receive any stipend, and shall be subject to no conditions as to duties or residence.

Dr. W. N. Shaw, of Emmanuel College, has been appointed to represent the University at the meeting of Imperial and colonial meteorologists, convened by the Royal Society of Canada, to be held at Ottawa in May.

Mr. J. S. Gardiner has been re-appointed demonstrator in animal morphology for five years as from October 1, 1907, and the appointment has been approved by the special board for biology and geology.

The special board for biology and geology reports that the Gordon Wigan income for biology and geology has been applied during 1907 as follows :—(*a*) a grant of 50*l*. a year to Dr. D. Sharp for a period of three years (1907–9), or such part of it during which he holds the curatorship in zoology; (*b*) a grant of 50*l*. a year for one year (1907) to Prof. Seward to enable the Botanic Gardens Syndicate to offer greater facilities for plant-breeding experiments; (*c*) a grant of 50*l*. out of the income for 1907 to Prof. Hughes, to enable Mr. E. A. N. Arber, of Trinity College, to continue his researches into the stratigraphical and geographical distribution of fossil plants.

LORD STANLEY OF ALDERLEY will distribute the prizes and certificates to evening students of the Battersea Polytechnic on Wednesday evening, February 19, and will deliver an address.

WE learn from the *Pioneer Mail* that the Maharaja of Darbhanga has made a gift of nearly 17,000*l*. to the Lieutenant-Governor for the purpose of constructing a library building in connection with the Calcutta University.

THE annual general meeting of the Association of Technical Institutions will be held on February 21 and 22 at the Drapers' Hall, Throgmorton Street, London. On the first day the association will be entertained at luncheon by the Drapers' Company, after which the new president, Sir Norman Lockyer, K.C.B., F.R.S., will deliver his presidential address. On the second day papers will be read on the best early training for a boy about to enter a technical institution or to take up a trade.

IN a recent report, the Director of Education for the United Provinces has, in accordance with the orders of the Government of India, described the progress of education in his district during the last five years. An abridgment of the report in the *Pioneer Mail* states that the attendance at the Thomason Civil Engineering College at Roorkee has increased from 336 to 495, and various improvements in and extensions of the curriculum have been effected. An agricultural college has been opened at Cawnpore. It is hoped that the medical college at Lucknow will be in working order soon. The Thomason College will, it is

expected, shortly develop into a technological institute for engineering purposes, and a technological institute for chemical matters will be established at Cawnpore. Another matter of high importance referred to in the report is the change recently made with the object of introducing more practical work into the course for the degree of Bachelor of Science—a necessary step to meet the growing demand for good teaching in science, which is evidenced by the doubling, in five years, of the number of affiliated colleges preparing for science degrees, and a large increase in the number of undergraduates studying science.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, December 12, 1907.—"On the Scattering of the $\beta$ Rays from Uranium by Matter." By J. A. **Crowther.** Communicated by Prof. J. J. Thomson, F.R.S.

The results of the experiments described are summarised as follows:—

(1) A parallel pencil of $\beta$ rays is scattered in its passage through matter, the scattering being practically complete after the rays have traversed a thickness of material which varies from 0·015 cm. for aluminium to 0·0002 cm. for gold.

(2) The scattering, after correction for the loss of energy, due to the absorption of the rays may be represented by an equation of the form $I/I_0 = e^{-\sigma d}$, where $d$ is the thickness of the material traversed by the rays, and $\sigma$ is the coefficient of scattering for the rays, $I_0$ being the initial intensity of a narrow parallel pencil of $\beta$ radiation, crossing a small fixed cross-section of the pencil, and I the intensity crossing the same cross-section when a thickness $d$ of material is placed in the path of the beam at a considerable distance from the fixed cross-section.

(3) The ratio of the coefficient of scattering $\sigma$ to the coefficient of absorption $\lambda$ is approximately constant for all the substances measured, its average value being about 13. The values of the ratio $\sigma/\rho$, where $\rho$ is the density, show similar variations to those for $\lambda/\rho$.

December 12, 1907.—"Preliminary Note on the Operational Invariants of a Binary Quantic." By Major P. A. **MacMahon,** F.R.S.

**Mineralogical Society**, January 21.—Prof. H. A. Miers, F.R.S., president, in the chair.—Zeolites from the neighbourhood of Belfast: F. N. A. **Fleischmann.** The author gave an account of a number of hitherto unrecorded zeolite localities near Belfast which he visited in November last. The localities described are quarries in the lower basalt of the neighbouring hills, the most important being two, the first situated on the north side of the hill, which is locally known as Cat Carne, the second on the north-east slopes of Collinward. The first quarry is the most prolific in zeolites in the neighbourhood, yielding fine specimens of apophyllite, analcite, chabazite, levynite, faroelite, &c. In the second quarry cavities are rare, but when they occur are, as a rule, large, and are usually lined with colourless tabular apophyllite crystals which reach sometimes an inch and a half across, and are associated with large hemispherical aggregates of natrolite. —Strüverite and its relation to ilmenorutile: Dr. G. T. **Prior** and Dr. F. **Zambonini.** The mineral was found in the pegmatite of Craveggia, N. Piedmont. In its crystallographic characters it is almost precisely similar to rutile, tapiolite, and ilmenorutile (F. Z.). Chemically (G. T. P.) it is closely related to ilmenorutile, and contains titanic, niobic, and tantalic acids with oxide of iron, in proportions corresponding approximately with the formula $Fe(TaNb)_2O_6.4TiO_2$. At first it was thought to contain zirconia as an essential constituent; the supposed zirconia, however, was shown on further examination to consist of niobic and tantalic acids, which, after the fusion of the mineral with $KHSO_4$ and treatment with water, had passed into solution with the titanic acid. In the presence of as much titanic acid as occurs in strüverite (40 per cent.) it was found that the greater part of the niobic and tantalic acids could thus pass into solution, and when a dilute solution of sulphuric acid (5 per cent. $H_2SO_4$) was used instead of water in treating the melt obtained with $KHSO_4$, the whole passed into solution. New analyses of ilmenorutile from the Ilmen Mountains and from Norway showed that the titanic acid has been previously much over-estimated, and is present, in the first case, only up to 53 per cent., and in the other to about 54½ per cent. The mineral from the Ilmen Mountains was also found to contain tantalic acid up to about 15 per cent. The most reasonable view of the composition of these minerals appears to be that they are solid solutions of tetragonal rutile ($TiO_2$) with the crystallographically similar tetragonal mossite or tapiolite, $Fe(TaNb)_2O_6$.—Twin structure: Dr. John W. **Evans.** The author adopts as a definition of a twin crystal that it is a crystal consisting of two component parts such that (*a*) parallel lines in general have not the same physical characters in the same direction in the two components; (*b*) one or more "twin-planes" exist such that all lines parallel to (1) any line in a twin-plane, or (2) the "twin-axis" normal to a twin-plane, have the same physical characters in the same or opposite directions in the two components. He shows that this definition includes all twins by reflection, rotation, or inversion (=reflection+rotation), and divides twin-axes into eleven classes according to the odd or even cyclic characters of the twin-axis, the relations between the terminations of the twin-axis, and the relations between the disposition in space of the structure of the two components. He describes twins as amphithetic, homothetic, or antithetic according as lines parallel to the twin-plane have in both components the same physical characters (1) in both directions; (2) in the same directions; or (3) in the opposite directions.—A simple method of drawing crystals of calcite and other rhombohedral crystals, and of deducing the relations of their symbols: Prof. W. J. **Lewis.** The author described a simple method of drawing crystals of calcite and other rhombohedral crystals, in which the principal axis and the twin-axis lie in the plane of the paper. The method is not well adapted for showing simple forms, but with combinations and twinned crystals the drawings closely resemble ordinary clinographic drawings, and are much more easily and rapidly constructed. The geometrical relations between the faces and the relations between the Millerian and Naumannian symbols are readily followed from these drawings. Some unusual twinned crystals of calcite were shown and described; one shows the form {917} twinned on (011), and another {13.0.$\bar{1}\bar{1}$} twinned on the same law.—The structure of perowskite from the Burgumer Alp, Pfitschthal, Tyrol: H. L. **Bowman.** The examination of the optical properties and etching figures of transparent cubic crystals from this locality confirms the interpretation of the structure of perowskite proposed by Baumhauer from the study of crystals from the Ural Mountains and from Zermatt. The crystals are mimetic, and belong to the orthorhombic system, the "cubes" being formed by a combination of basal pinacoid {001} and a prism {110} with an angle of 90°, and having a lamellated structure due to twinning about faces of {110} and {111}.

**Geological Society**, January 22.—Sir Archibald Geikie, K.C.B., Sec.R.S., president, in the chair.—The origin of the pillow-lava near Port Isaac in Cornwall: Clement **Reid** and Henry **Dewey.** The Upper Devonian strata around Port Isaac consist of marine slates, in which occurs a sheet of pillow-lava. The pillows measure usually from 2 feet to 5 feet in diameter, but range up to 8 feet. The individual pillows are disconnected. Their mutual relations seem to prove that they were soft when deposited. Each pillow shows internally a central vacant space or open sponge, succeeded by a thick shell of vesicular lava, followed by a shell of banded rock. The whole mass is so vesicular that it must have been very light. The association with fine-grained marine strata shows that this lava was probably submarine. The specific gravity of the whole mass must have been low, not greatly exceeding that of sea-water. The lava seems to have been blown out into thick-walled bubbles. The mass was for a time in the spheroidal state, and the sheet could flow like a liquid. This eruption seems to have been analogous to that of Mont Pelée, described by Dr. Tempest Anderson and Dr. Flett, except that it was submarine instead of subaërial.—The subdivision of the Chalk at Trimmingham (Norfolk): R. M. **Brydone.**

**Royal Anthropological Institute**, January 28.—Annual meeting.—Prof. D. J. Cunningham, F.R.S., in the chair.—Anniversary address, anthropology in the eighteenth century: Prof. **Cunningham.** The work of the period centres round five men, Camper, White, Blumenbach, Prichard, and Lawrence, of each of whom an interesting account was given.

MANCHESTER.

**Literary and Philosophical Society**, November 26, 1907.—Prof. H. B. Dixon, F.R.S., president, in the chair.—Demonstration illustrating the formation of acetylene from elementary substances: Prof. E. **Knecht.** On heating a small piece of calcium on charcoal before the blowpipe, the metal readily took fire, and, after burning with a brilliant orange flame for about two seconds, sank into the mass of the charcoal. After the latter had been allowed to cool, it was broken up, when a hard lump was found which yielded acetylene on treatment with water.—New reactions for the characterisation of mercerised cotton: J. **Hübner.** The author has found that, on immersing mercerised and ordinary cotton in a solution of iodine in saturated potassium iodide solution for a few seconds, and afterwards washing with water, the colour of the mercerised cotton quickly changes to a bluish-black, whilst the ordinary cotton becomes lighter in colour and changes to a brownish-chocolate shade. After further washing the ordinary cotton becomes white, whilst the mercerised material remains a bluish-black colour, which fades very slowly on prolonged washing.—The direct combination of carbon and hydrogen: H. F. **Coward.** In experiments made with small quantities of highly purified carbon, the author has obtained from 0·1 gram of carbon, containing a maximum of 0·9 c.c. of hydrogen, 100 c.c. to 120 c.c. of methane by direct union with hydrogen.

December 10, 1907.—Prof. H. B. Dixon, F.R.S., president, in the chair.—Some notes on the mammals of Lundy Island: T. A. **Coward.** The notes were the outcome of a few days spent in trapping on the island; some of the specimens obtained were exhibited.—Notes on some destructive mites: C. G. **Hewitt.** The author described a new mite, *Lohmannia insignis*, Berl., var. *dissimilis*, n. var., which was found feeding on the scale-leaves of tulip bulbs. Two other mites which have occurred in the Manchester district were described, viz. *Rhizoglyphus echinopus* and *Glycyphagus spinipes*.

January 14.—Prof. H. B. Dixon, F.R.S., president, in the chair.—The atomic weight of chlorine: Dr. E. C. **Edgar.** The method used to re-determine this constant was to burn pure dry chlorine, at the tip of a quartz jet, in an atmosphere of pure dry hydrogen in a quartz "combustion vessel"; the hydrogen chloride formed was condensed in a limb of it by liquid air. As the mean of eight experiments, the atomic weight of chlorine calculated from the ratio weight of chlorine burnt/weight of hydrogen burnt is 35·194; from the ratio weight of hydrogen chloride caught−weight of hydrogen burnt/weight of hydrogen burnt it is 35·193 (atomic weight of hydrogen = 1). If the atomic weight of oxygen is taken as 16, that of chlorine becomes 35·462 and 35·461 respectively.—The production of photographs in the colours of nature: A. **Brothers.**

January 28.—Prof. H. Lamb, F.R.S., in the chair.—A new type of dynamical stability: A. **Stephenson.** A system in a position of equilibrium and capable of oscillation about that position may be acted on by periodic force in such a way that no oscillation is generated; thus the equilibrium of a pendulum is not disturbed by the action of vertical force. The object of the communication was to establish the remarkable property of this non-generating type of disturbance in maintaining an equilibrium which would otherwise be unstable.

PARIS.

**Academy of Sciences**, February 3.—M. A. Chauveau in the chair.—The existence of crystallised sodium fluoride as an element of the nepheline syenites of the Los Islands: A. **Lacroix.** These rock specimens were collected by M. Villiaume from Ruma. In order that unweathered material only should be obtained, the specimens were removed by blasting with dynamite, and about half a ton of rock was brought to Paris. One syenite was found to contain a new mineral, the mineralogical and physical characters of which are described in the present paper. It has a smaller refractive index ($n_D = 1{\cdot}328$) than any other known mineral, and appears to consist of sodium fluoride, with traces of manganese, calcium, potassium, and possibly zirconia. The mineral is named villiaumite, and its mode of origin is discussed.—The heat of formation of the anhydrous oxides of strontium and barium: M. **de Forcrand.** Strontia and baryta cannot be purchased pure, but if the hydroxides are placed in a platinum boat and heated to 850° in a current of dry hydrogen, absolutely pure, white SrO and BaO can be obtained, the platinum boat not being attacked. The heats of solution found are higher than those of Thomsen, possibly on account of the greater purity of the material.—Observations of the sun made at the Observatory of Lyons during the third quarter of 1907: J. **Guillaume.** The results are summarised in three tables, giving the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude respectively.—The development of an arbitrary function according to the functions of Laplace: Léopold **Fejér.**—A new electric arc furnace applicable to laboratory researches: Louis **Clerc** and Adolphe **Minet.** For an E.M.F. of 50 or 60 volts, by suitably proportioning the area of cross-section of the furnace to the current, an arc of any length can be obtained. In the furnace figured, using from 1 to 2 kilowatts, any desired temperature from a dull red heat upwards can be obtained, and capable of dealing with from 2 to 40 grams of material.—The use of flames as valves for high-tension alternating currents: André **Cathiard.**—Some anomalous modifications of the band spectra of various compounds in the magnetic field: A. **Dufour.** M. Henri Becquerel has attributed the peculiar behaviour of the bands of calcium fluoride, previously described by the author, to the presence of impurities. This view would appear to be improbable, since similar phenomena are now shown to be exhibited by the chlorides and fluorides of all the alkaline earths.—The reduction of indigo by the electrolytic method: H. **Chaumat.** The method recently described by the author was anticipated by Goppelsröder in 1882.—Some complex salts of iron in which the iron is masked: P. **Pascal.** Recently precipitated ferric pyrophosphate is soluble in sodium pyrophosphate, the solubility being independent of the temperature and concentration of the sodium salt. When the solution is saturated, the constituents are in the proportion $Fe_4(P_2O_7)_3 : 3Na_4.P_2O_7$, which may be written $Na_6Fe_2(P_2O_7)_3$, or sodium ferropyrophosphate comparable with the ferricyanide, and the behaviour of the salts, together with the isolation of the acid itself, confirm the view that such a complex acid exists.—Some new derivatives of camphenylone: its constitution: L. **Bouveault** and G. **Blanc.**—The order of addition of ammonia to organic α-oxides of asymmetrical structure: K. **Krassousky.** The reactions between ammonia and trimethylethylene oxide and *iso*butylene oxide have been studied, and the conclusion is drawn that in the combination of ammonia with asymmetrical α-oxides, the hydroxyl group is found attached to the carbon atom containing the least hydrogen.—The genesis of certain minerals of alumina and iron. Lateritic decomposition: Jean **Chautard** and Paul **Lemoine.**—The presence of scapolite gneiss and cipolin in Dahomey: Henry **Hubert.**—The origin of the fertile soils of western Morocco: Louis **Gentil.**—The solution of saccharose isotonic with the eggs of Strongylocentrotus: Jacques **Loeb.** The author contests that his experimental results are in strict agreement with those of M. Delage.—The morphology and evolution of the Sabellarians of Saint Joseph: Ch. **Gravier.**—Contribution to the study of the calorific solar radiation: C. **Féry** and G. **Millochau.** An account of work done in the observatory at the summit of Mont Blanc in 1907. The apparatus was standardised by pointing at an electric furnace, and gave an effective absolute temperature for the centre of the solar disc of 5555° C. The value found for this temperature in 1906 was 5620° C.

CALCUTTA.

**Asiatic Society of Bengal**, January 8.—Notes on Indian mathematics, ii., Aryabhata: G. R. **Kaye.** The most important part of this paper consists of a translation

of Āryabhata's "Ganita," and a comment thereon. These are prefaced by brief notes which explain the position occupied by Aryabhata in the history of mathematics. The point of view of the writer differs from that of those who have previously treated the subject in that he holds that it is beyond all doubt that Aryabhata's work owes its origin to the Alexandrian school of mathematicians. Āryabhata does not claim to be the discoverer of the rules he gives, and it is thought that the "Ganita" was intended by him to be supplementary to the mathematical knowledge of the Hindus of his time. The "Ganita" is examined in close detail, and abundantly confirms this hypothesis. The claims that have been made for Aryabhata—that he was the inventor of our modern system of arithmetical notation; that he discovered a more accurate value for $\pi$ than any of his predecessors; that he was the first to give a systematic solution for indeterminate equations of the first degree—are shown to be unsound (see also p. 347).—Studies in experimental breeding of the Indian cottons: an introductory note: H. Martin **Leake**. Breeding experiments have been undertaken at Cawnpur, and the third generation has now been reached. As a result of numerous measurements of the leaf it has been found that if narrow-lobed and broad-lobed leaved plants be crossed, the proportions of the leaves in the first generation ($F_1$) approximate remarkably to the arithmetic mean of those of the two parents, and this appears to be true for all crosses, whether they be made between the extreme forms of *Gossypium neglectum* or between such divergent types as *G. arboreum* and *G. herbaceum*. In the $F_2$ generation of crosses, plants with typical broad and with typical narrow-lobed leaves appear, just as ascertained laws of heredity teach us to expect. From the way in which intermediates such as have been artificially raised occur naturally in the fields of the United Provinces of Agra and Oudh, it is apparent that cross-fertilisation is common. Further, in illustration it is cited that a packet of seed of *G. arboreum* taken without precautions yielded two out of fourteen plants the parentage of which was obviously impure, and which therefore stand as evidences of natural cross-fertilisation of *G. arboreum* by some other species of Gossypium.

## DIARY OF SOCIETIES.

*THURSDAY*, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.—The Constitution of the Electric Spark: T. Royds.—On the Determination of Viscosity at High Temperatures: Dr. C. E. Fawsitt.—The Effect of Hydrogen on the Discharge of Negative Electricity from Hot Platinum: Prof. H. A. Wilson, F.R.S.—The Decomposition of Ozone by Heat: Dr. E. P. Perman and R. H. Greaves.

ROYAL SOCIETY OF ARTS, at 4.30.—The New Imperial Gazetteer of India: R. Burn.

MATHEMATICAL SOCIETY, at 5.30.—Proof that every Algebraic Equation has a Root: Dr. H. A. de S. Pittard.—On the Uniform Approach of a Continuous Function to its Limit: Dr. W. H. Young.—Note on $q$-differences: Rev. F. H. Jackson.—An Extension of Eisenstein's Law of Reciprocity (Second Paper): A. E. Western.—Conformal Representation and the Transformation of Laplace's Equation: E. Cunningham.

*FRIDAY*, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—Biology and History: Dr. C. W. Saleeby.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

PHYSICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.—Annual Meeting.—President's Address: Malacology *versus* Palæoconchology: B. B. Woodward.

*MONDAY*, FEBRUARY 17.

ROYAL SOCIETY OF ARTS, at 8.—The Theory and Practice of Clock Making: H. H. Cunynghame, C.B.

VICTORIA INSTITUTE, at 4.30.—Philosophy and Evolution: Prof. H. L. Orchard.

*TUESDAY*, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—Membranes: Their Structure, Uses and Products: Prof. William Stirling.

ZOOLOGICAL SOCIETY, at 8.30.

ROYAL STATISTICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Shaft-sinking at the Horden Colliery, South-east Durham: J. J. Prest.—The New York Rapid-transit Subway: W. B. Parsons.

*WEDNESDAY*, FEBRUARY 19.

GEOLOGICAL SOCIETY, at 8.—Notes on the River Wey: H. Bury.

ROYAL MICROSCOPICAL SOCIETY at 8.—Eye-pieces for the Microscope: E. M. Nelson.—The Life-history of a New Protophyte: Rev. Eustace Tozer.—On Dimorphism in the Recent Foraminifer *Alveolina boscii*: F. Chapman.—*Exhibits*: Slides illustrating the Life-history of some Diptera: C. L. Curties.—An Improved Mercury-Vapour Lamp: J. E. Barnard.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Formation of Snow Rollers: C. Browett.—Comparison of Ship's Barometer Readings with Those Deduced from Land Observations: E. Gold.

*THURSDAY*, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—Notes on the Application of Low Temperatures to some Chemical Problems. (1) Use of Charcoal in Vapour Density Determination. (2) Rotatory Power of Organic Substances: Sir James Dewar, F.R.S., and Dr. H. O. Jones.—On the Osmotic Pressure of Compressible Solutions of any Degree of Concentration. Part II. Cases in which both Solvent and Solute are Volatile: A. W. Porter.—Effects of Self-induction in an Iron Cylinder when traversed by Alternating Currents: Prof. Ernest Wilson.

ROYAL INSTITUTION, at 3.—Wood: its Botanical and Technical Aspects: Prof. W. Somerville.

INSTITUTION OF MINING AND METALLURGY, at 8.

LINNEAN SOCIETY, at 8.—Experiments with Wild Species of Tuber-bearing Solanums: A. W. Sutton.—The Life-history and Larval Habits of Tiger Beetles (Cicindelæ): Dr. V. E. Shelford.—On a Possible Case of Mimicry in the Common Sole: Dr. A. T. Masterman.—*Exhibit*: Stereoscopic Photographs of Alpine Plants in Natural Colours: T. Ernest Waltham.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electrical Power in Railway Goods Warehouses: H. Henderson.—Electric Power in Docks: C. E. Taylor.

CHEMICAL SOCIETY, at 8.30.—The Action of Thionyl Chloride and of Phosphorus Pentachloride on the Methylene Ethers of Pyrocatechol Derivatives: G. Barger.—The Preparation of Conductivity Water: H. Hartley, N. P. Campbell and R. H. Poole.—Derivatives of *para*-Diazoiminobenzene: G. T. Morgan and Miss F. M. G. Micklethwait.—A Study of the Diazo-reaction in the Diphenyl Series: G. T. Morgan and Miss F. M. G. Micklethwait.—Organic Derivatives of Silicon. Part VI. The Optically Active Sulphobenzylethylpropylsilicyl Oxides: F. S. Kipping.—A Simple Manometer for Vacuum Distillation: N. L. Gebhard.

*FRIDAY*, FEBRUARY 21.

ROYAL INSTITUTION, at 9.—The Ether of Space: Sir Oliver Lodge, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual Meeting.—Tests of a Live Steam Feed-water Heater: Prof. J. Goodman and D. B. MacLachlan.

## CONTENTS.