THURSDAY, JULY 24, 1902.

THE ENCYCLOPÆDIA BRITANNICA.

The Encyclopaedia Britannica. Vol. xxvi. Aus.-Chi. (Vol. ii. of the tenth edition). Pp. xxii + 763. (London and Edinburgh: Adam and Charles Black; and The *Times*, Printing House Square, London, 1902.)

SEVERAL articles of scientific interest are contained in this volume, but limitations of space will only permit us to refer to a few of them. Among the subjects of contributions, in addition to those mentioned below, are Balanoglossus, by Dr. A. Willey; George Bentham, by Sir William T. Thiselton-Dyer; Birds, by Dr. H. Gadow; Brachiopoda, by Mr. A. E. Shipley; Calibration and Calorimetry, by Prof. H. L. Callendar; and the Channel Tunnel, by Prof. Boyd Dawkins. There are also articles on all geographical divisions having names between Austria and Chicacole.

The subject-matter of the article on "Bacteriology" has been divided into two sections, general and pathological, the former of which has been contributed by Prof. Marshall Ward. Commencing with a brief introduction upon the botanical position and affinities of the Schizomycetes, their general morphology, structure, flagellation and sporulation are then considered, the difficulties of classifying them discussed, and an outline of Fischer's system of classification detailed. The life and functions of the various classes of bacteria are next dealt with, and a brief, but sufficient, account is given of their growth, action of physical agents upon them, and of the nitrifying, cellulose, sulphur, pigment, phosphorescent and other forms, of the various fermentations, and of symbiosis. The effects of light upon bacteria are described, but we are inclined to think that the author lays too much stress upon this agent as a factor in the bacterial purification of streams, &c.; nor is it at all certain that the cure of lupus effected by the "light" treatment is due to the bactericidal action of the light rays.

In dealing with the bacteriosis of plants, it is pointed out that the evidence of the bacterial invasion of vegetable tissues must be accepted with caution and be carefully controlled, as in the majority of instances the bacteria are secondary, and have gained access along the dead hyphæ of an invading fungus or through the punctures due to aphides or other insects.

Not the least interesting and instructive portion of this article is the brief discussion of the possible sources of energy which contribute to the wonderful activities exhibited by these minute organisms.

The whole of this section, while showing a wide and comprehensive grasp of the subject, is a model of conciseness, and its value is enhanced by several original illustrations.

The pathological section is from the pen of Prof. Muir, and, after an historical introduction, the methods employed for the study of the bacteria are summarised. The general features of infection are then considered, and the nature of toxins, disease-production, susceptibility and immunity are briefly, but sufficiently, discussed; in fact, we have been unable to note any omission of importance.

The formation of antitoxin and the nature of the antagonism between antitoxin and toxin are next considered, and this leads naturally to an exposition of Ehrlich's "side-chain" theory, which is clearly described. Lastly, the nature of anti-microbic sera and the phenomena of bacteriolysis, of agglutination and of phagocytosis are considered, and another admirable survey is concluded with a few critical remarks upon natural immunity.

In the article upon "Brewing," by Dr. Schidrowitz, the reader is presented with an able summary of modern practice in this important industry, and much additional information is given, statistical and legal, and upon such subjects as the cultivation of barley for malt, malt and malting, hops, and malt and hop substitutes. The process of mashing and the changes which ensue, fermentation and the practical application of Hansen's discoveries, and brewing with pure cultures are briefly described. The article seems to be well up to date; for example, Buchner's yeast-cell extract or "zymase" and the theories respecting its nature are mentioned.

Beri-beri, that remarkable disease having the characters of a multiple peripheral neuritis, is described by Dr. Shadwell, his description, however, being mainly based upon Manson's writings (referred to, by the way, as Sir Patrick; may it be an omen). Ross's suggestion that beri-beri is a form of arsenical poisoning is alluded to, but is not considered probable. The micro-organisms of Pekelharing and Winkler and of Rost are not mentioned, and the absence of fever in the disease does not necessarily exclude a micro-parasite, as is suggested.

The article on cancer, also from the pen of Dr. Shadwell, deals mainly with the statistical problems presented by this dread disease; the pathological ones, we understand, will be discussed in another place. With regard to the alleged increase of cancer, it is considered that

"on the whole it must be held that though there has probably been some increase, it has not been satisfactorily proved and is certainly less than is supposed."

R. T. H.

The supplementary article on chemistry contributed by Prof. Armstrong fills thirty-eight pages and surveys almost the whole field of scientific chemistry. The task of reviewing the article is such that I have felt inclined to shirk it altogether; for the article proves to be, not so much a record of recent advances in chemistry as a manifesto of Prof. Armstrong's own views on the chief phenomena and problems of modern chemistry. With these views I am entirely out of sympathy. I should be willing enough to say why, but I should want nearly as many pages to traverse Prof. Armstrong's statements as he has occupied in making them. I can do no more than give one or two examples of my meaning.

At the outset of the article we have a reproduction of the table of the elements which Prof. Armstrong recently brought before the Royal Society. In this table all atomic weights have to be whole numbers, and argon and its companions have to form diatomic molecules; these and other things *have* to be what they have been demonstrated *not* to be, so far as the most careful, accurate and trusted work of a generation of chemists can be said to have afforded any demonstration at all.

One would expect some compensation for this; but in exchange for our most precious experimental data I can

find nothing more substantial than a number of integers which mutely stand and wait for elements not yet discovered, or not yet isolated in as pure a state as may be possible.

I suppose we must view this table, and in fact the whole article, in the light of Prof. Armstrong's dictum,

"that imagination and even sentiment play an important part in chemistry, and that if too narrowly and rigidly interpreted, facts may become very misleading factors."

I do not know that this is true, but I feel convinced that the ruthless treatment which facts receive in this new table is not calculated to further exact science.

I must pass over the doctrine of residual affinity and the view of chemical combination as reversed electrolysis which figure so largely in the article. Their application to facts involves a most intricate discussion. These views have been before the chemical world for many years, and I do not think the measure of acceptance which they have gained warrants the prominence which Prof. Armstrong gives them in a general article.

Lastly, in dealing with the ionic theory Prof. Armstrong begins, it is only fair to say, by giving an impartial account of it, with illustrations of its application to chemical phenomena. He adds to this a reiteration of his own objections to the theory and an exposition of possible alternatives which he thinks preferable. This may be allowable, but I cannot pass over the serious charge which is made, that

"the advocates of the dissociation hypothesis have declined even to consider the objections which may be raised to it from the chemist's side."

I am aware of the historic fact on which this statement is based, but I consider it most unfair to leave the reader of the Encyclopædia article under the impression that the ionic theory is entertained as a dogma by the large number of eminent chemists in whose hands it has been the means of effecting such remarkable advances of knowledge.

I do not wish, of course, to imply that in this article Prof. Armstrong has done otherwise than give an honest account of the state of chemistry as it appears to him, and I affect no claim to compete with him in dictating the true faith. But I do say that the whole article is so imbued with the peculiar opinions of the author as to be the polemic of an individual rather than a description of the state of chemistry as it appears to the vast majority of those who follow the craft. For this reason it does not appear to me to be well suited for an encyclopædia.

ARTHUR SMITHELLS.

SUBMARINES.

Les Bateaux Sous-Marins et les Submersibles. Par R. D'Equevilley, Ingénieur Civil des Constructions Navales, Ancien Ingénieur aux Forges et Chautiers de la Méditerranée. (Paris: Gauthier-Villars, 1901.)

IT is curious to note the difference in the general appreciation of the submarine in England and in France. Here until recently these engines of destruction do not appear to have been taken seriously by our professional guides, and, so far as the public know, but little has been done to prove their value, whereas in France, not only are there many already belonging to the Navy, but public appreciation of their utility is such that engineers will have to make themselves familiar with their history and their present lines of development. A handy little book such as this at three francs is likely, therefore, to find a ready sale.

The first chapter relates to the history of the subject under the heads of the different countries. It is interesting to us to note that the earliest submarine mentioned, *La Hollande*, was constructed on the Thames in 1620 and was worked in some way by oars, greatly to the delight of James I. The English have not done much in this line, nor have they been greatly encouraged by the authorities, for we are told that Johnson, early in the nineteenth century, navigated under the Thames in a submarine, which was confiscated by the Government on the pretext that he was going to deliver Napoleon. The builder of the submarine and of the motor-car seem to have been about equally stimulated.

It is surprising to see how, in almost every country but England, the problem has been attacked by many inventors, France apparently taking the lead.

The conclusion of the second chapter, that "habitability" is the most easy thing to attain, is not what would be expected, nor does it seem quite to agree with the accounts of the exhaustion of the men that have appeared at times in the newspapers.

The description of the view obtained from a submarine is interesting. At the depth of only a few metres it appears as if the boat is at the centre of a great circular hall without a roof, as refraction prevents skylight from penetrating beyond the critical angle. It is interesting to contrast this with the appearance of the earth seen from a balloon. Here the observer, as the effect of perspective, seems to be in the centre of a vast concave bowl. The colour of the water is described as favourable for lighting by the electric arc, as the course can be seen for 50 metres ahead.

Under the head of security, the author offers some rather chilly comfort, for he explains that as the submarine is of necessity of about the same density as the water, if you chance to run on a rock there is very little to prevent your glancing off, whereas with a surface-boat the weight at once prevents its rising in a similar way. It must, however, be remembered that if a liner merely scrapes laterally against quite an insignificant iceberg the plating is ripped off as long as the contact lasts. Of course, in consequence of the higher speed and greater dimensions, inertia is far more formidable in this case, but it is difficult to believe that even a submarine could do much rock scratching with impunity. Lest, however, anyone should become too confident, the author points out that one danger always exists—that of not being able to go up, up, up. For this reason the system always employed in French submarines has much to recommend it. These, even when they descend, retain a considerable buoyancy tending to make them rise, but they only actually descend by the action of horizontal rudders or aqua planes corresponding to the aëroplane of a flying machine. Such an arrangement will not permit of remaining below the surface voluntarily when at rest.

The chapter on the discharge of torpedoes is necessarily disappointing, as the author is unable to disclose information of a confidential nature.

The most interesting chapter is that which deals with the different stabilities on which the successful navigation depends. There can be no stability of buoyancy when totally immersed; the vessel either rises to the surface, or if it is ever so little heavier than the surrounding water it descends with ever-increasing velocity as the shell becomes compressed until the bottom is reached. When, however, the ship is moving longitudinally, the horizontal rudders determine the rise or fall. The author has no word of commendation for the method of rising or sinking by means of vertical screws.

After discussing shortly the interesting question of lateral stability when floating and when immersed, the author proceeds to the explanation of the effect of the position of the horizontal rudder on the good behaviour of the ship when diving. It seems that the old contest between rear and front steering wheels in tricycles has its counterpart here, and that the front steering, as in the other case, leads to more steady and certain results. The stability of direction depends upon there being plenty of length with fine lines aft. We are told that the submarine of the French Navy, after a run under water of several miles, can come to the surface again on exactly the same course as that which was followed at first.

A series of chapters on motors—steam, electric, petrol—and on tactics bring the author to his conclusion, which shows that he and the French Navy are in grim earnest, and that in his opinion so powerful and insidious a weapon will make naval warfare too terrible to be tolerated any longer. However confident the author may be, and whatever the truth may be, there is in this country much scepticism as to the power of the submarine, as will be gathered from an excellent article in the current number of *Whitaker*, p. 694. C. V. B.

THE DYNAMICAL FOUNDATIONS OF THERMODYNAMICS.

Elementary Principles in Statistical Mechanics. By J. Willard Gibbs, Ph.D., LL.D. Pp. xviii + 207. (New York: Charles Scribner's Sons; London: Arnold, 1902.) Price 10*s.* 6*d.* net.

WHERE a branch of science has been approached exclusively from the deductive side or exclusively from the experimental side, it is far easier to form a correct estimate of our state of knowledge in it than is the case where experimental and deductive methods have been continuously worked side by side. The study of rational dynamics has afforded excellent mental training for those who have made the greatest marks in the world as physicists, notwithstanding the fact that the conclusions arrived at in rational dynamics are in direct contradiction to ordinary experience. Thus it is impossible to verify experimentally that the times taken by *particles* to slide down *perfectly smooth* chords of a vertical circle are equal, and the phenomena of Nature are far too complicated to allow of an experimental test of the velocity with which a boy would have to throw a cricket ball *in vacuo* in order to give it a horizontal range of 200 yards. In the study of thermodynamics, on the other hand, where the experimental has preceded the deductive treatment, as has been the case ever since Joule discovered the so-called mechanical equivalent of heat, much confusion and failure to appreciate correctly our state of knowledge have necessarily resulted, and the only way of evolving order out of chaos is to formulate a theory on a purely deductive basis founded on certain hypotheses. The interest of the theory from a physical standpoint will then depend in the agreement or want of agreement between the conclusions of the theory and the results of observation.

In his study of the equilibrium of heterogeneous systems, Prof. Willard Gibbs, starting from the deductive side, gained a point of vantage which has proved of the greatest possible value to the experimental physical chemist. In his present work the same author is to a large extent following in the footsteps of Boltzmann, Watson and other writers, but at the same time he is imparting a great amount of his own originality, both in form and in treatment, to their work. It is impossible to read this volume without feeling that Prof. Gibbs has been to a great extent imbued with the same spirit which led Dr. Watson to produce the second edition of his excellent treatise on the "Kinetic Theory of Gases." This is a valuable feature, for it would be difficult to produce in a small compass a better introduction to the purely deductive study of the kinetic theory than has been given us by Dr. Watson. But Prof. Gibbs has gone further, and has not only discussed the subject at somewhat greater length, but by clothing the investigation in new language, under the title of "Statistical Dynamics," has presented it in a form in which it can be studied quite independently of any molecular hypothesis as a purely mathematical deduction from the fundamental principles of dynamics.

The study of statistical dynamics is based on the consideration, not of a single body or system, but of a very large number of such systems, and such a collection Prof. Gibbs calls an *ensemble*; moreover, in the course of the work it is found necessary to distinguish between *grands ensembles* and *petits ensembles*. The principle underlying the whole investigation is the well-known determinantal relation (corresponding to § 8 of Watson's book) connecting the initial and final values of the multiple differentials of the coordinates and momenta of an *ensemble*. The precise meaning of this relation has always been exceedingly difficult to grasp. It surely adds considerably to our clear understanding of the property to have it now enunciated as the "principle of conservation of extension in phase." A slightly modified form of enunciation gives the principles of conservation of density in phase, and of probability of phase. A further property is that extension in phase is an invariant in that it is independent of the choice of coordinates.

The most interesting distribution of the coordinates and momenta of an *ensemble* is that determined by a probability coefficient of the form $e^{-h\mathrm{E}}$ which is commonly known as the Boltzmann-Maxwell distribution. Prof. Gibbs calls this the *canonical* distribution, and the limiting case of $h=0$ where the coefficient of probability is unity is called the *micro-canonical* distribution. The

discussion of certain maximum and minimum properties leads to considerations of the changes which take place in an *ensemble* of system both when left to itself and when subjected to external influence, also of the results obtained by bringing two canonically distributed *ensembles* within influence of each other. The general conclusion is that there exist in statistical mechanics processes strictly analogous to many of those occurring in thermodynamics. Thus equations may be formulated closely resembling those which represent the irreversible heat-changes between two bodies of unequal temperature. When it comes to choosing a pair of conjugate variables to represent temperature and entropy, it is found that these are not uniquely determined, but that several systems are possible, a fact previously brought out, indeed, by von Helmholtz in his "Statics of Monocyclic Systems."

The last chapter deals with *ensembles* analogous to mixtures of different kinds of molecules, and these the author calls *grands ensembles*. They differ from the *petits ensembles* previously considered in the fact that they contain particles or systems of different kinds which may be present in different numbers.

Prof. Gibbs's work is not very easy to read, and it hardly seems appropriate to apply the title "elementary" to it; but the difficulties are no doubt inherent in the subject. It does much to elucidate the conditions under which a body composed of molecules obeying the equations of rational dynamics presents to beings of comparative dimensions similar to those of the human race attributes which may be summed up in the single word "temperature." G. H. BRYAN.

AN ATTEMPT AT ORIGINALITY IN THE TEACHING OF ZOOLOGY.

A Course in Invertebrate Zoology. By Henry Sherring Pratt, Ph.D. Pp. xii + 210. (Boston, U.S.A., and London: Ginn and Co., the Athenæum Press, 1902.)

DR. PRATT'S book, defined on its title-page as a guide to the dissection and comparative study of invertebrate animals, is the latest of the many novelties which aim at effecting an improvement on the world-famous Huxleyean system, to which acknowledgment is made. The author sets out with the intention of enabling the student to study the larger groups as a whole, instead of detached types of different groups, as he claims is now generally done. In order to achieve this end, he deals in 174 pp. with no fewer than thirty-four representative animals, and the headlines of some of his chapters even bear the names of two alternative genera, for which a single description is made to suffice. Although this gives an average of little more than five pages for each animal, it must be admitted that, so far as they go, the descriptions and instructions, of necessity of a very elementary form, are lucid and correct.

Without going into further detail concerning the body of the book, it may be said that the essence of its novelty lies rather in the appendix and its associated classificatory scheme. This leads off with a copy of Claus's 1887 system, in which, as an all-conspicuous feature, the Sponges were classed as Cœlenterates, the Enteropneusta as Echinoderms. Then follows a short, but withal a useful, historical sketch of the growth of classificatory systems, from Cuvier to Hatschek, whose scheme of 1888 is given in tabular form, with a succeeding list of "short definitions" which are supposed to be *en suite*, and of which it is remarked that while not exhaustive they "are intended but simply to characterise the various groups in the fewest possible words." The first great subdivision is into subkingdoms (Protozoa and Metazoa), divisions follow, then types, classes, and orders. When, however, on comparison, one finds that while the table provides for five types (Spongiaria, Cnidaria, Trochozoa, Echinodermata, and Chordata), the three first-named are for the definitions numbered in order, and the two last-named are numbered five and six, one is led to seek for number four. The search is vain, since table and definitions do not agree. Most of the descriptions, moreover, in their would-be conciseness, are inadequate. And when with this it is said that, under type Trochozoa, defined as "Metagastrozoans whose common descent and relationship are shown by their possession in some form of a trochophore larva or of an embryonic form allied to it," there are included as subtypes Vermes, Articulata, and Mollusca, further comment becomes unnecessary, except to give it as our opinion that whatever the future of the zoological training of the young, it will not develop on these lines.

The above analysis might be extended with even humorous results; but whatever the good points the book may possess, failure appears to us certain in the attempt to do too much. The would-be new departure is foreign to the best traditions of the Huxleyean system. In the later development of this, the thorough mastery of type-structure has come to be regarded as an alphabet, by which the student learns to read, and the broadest possible survey of the structural limitations of the several groups of which the types are members, as a reading lesson to follow, under the special guidance of the teacher.

OUR BOOK SHELF.

Slide Rule Notes. By Lieut.-Colonel H. C. Dunlop, R.F.A., Professor of Artillery at the Ordnance College, and C. S. Jackson, M.A. (Barrister-at-Law), Instructor in Mathematics R.M. Academy, late Scholar Trinity College, Cambridge. Pp. 66. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1901.)

THE slide rule is one of those things which can be less readily explained in writing than verbally. A few words explaining the principle so as to develop the slide rule sense is all that is required to put anyone of reasonable quickness in the way of becoming an adept. On the other hand, the full exposition of the logarithmic theory of the mode of setting for each class of operation, which is essential where the art is to be taught from a book, makes the thing seem so complicated and difficult to remember, that many who would find no difficulty in being taught by the first method might well give it up in despair at the very outset when taught only by the second method. However, it is not given to everyone to be able to find an adept with a power of exposition, and so the book becomes a necessity.

In the writer's opinion, the introductory chapter on the properties of logarithms does not furnish the most practical method, though of course it is eminently scientific, of showing the way to the use of the slide rule. But given that it is to be taught as school subjects are taught, *i.e.* so that the learner cannot see what the object is until he has arrived there, there is nothing but commendation for these notes, as they are called. Many as the books are on the slide rule, the writer of this notice has never seen one so complete and so logical. In addition to the regular uses which are always explained, though many who are familiar with the A, B, C and D lines fight shy of the trigonometrical lines, the solution of quadratic and cubic equations, exponentials and the plotting of curves are illustrated by many examples. Dr. Roget's log. log. line is shortly described, but no reference is made to Lanchester's radial cursor, which makes thermodynamical calculations with γ-wise exponents almost as direct as plain multiplications, and far more convenient than with the log. log. line.

One unfortunate misprint occurs near the beginning, where the construction of the rule is being explained, and the distance from 1 to 2 or log 2 is stated to be 3·03 instead of 3·01. C. V. B.

Injurious and Useful Insects: an Introduction to the Study of Economic Entomology. By L. C. Miall, F.R.S. Pp. viii+256. (London: George Bell and Sons, 1902.) Price 3*s.* 6*d.*

THIS little book is unfortunate in its title. One would expect to find all its pages given up to economic entomology; instead we find much valuable space taken up with long accounts of a carnivorous water beetle (*Dytiscus marginalis*), pp. 32 to 37; the tiger moth (*Arctia caja*), pp. 58 to 62; the harlequin fly (Chironomus), pp. 100 to 125. What such subjects have to do with economic entomology it is difficult to understand. At the same time, some interesting accounts of various economic species and groups are given, such, for instance, as the cockchafer, wireworm, turnip-flea, the gooseberry saw-fly, the hive bee, the silkworm, aphides and scale insects, &c. The accounts of the life-histories of these are all interestingly and accurately compiled, but when the practical part comes the work fails; compilation mainly from foreign sources, unless backed up by practical experience of such matters, is usually fatal.

For instance, no mention is made of trapping the adult click-beetles, the parents of the ravenous wireworm, yet it is the only way any good is done; nor is the practice of growing a crop of mustard on wirewormy land mentioned, and what is the use of advising the American remedy for the ground form of woolly aphis—tobacco-dust dug into the soil—in this country? The work is divided into four parts, dealing with the following subjects:—Part i., preliminary lessons, giving an excellent account of the structure of an insect; part ii., lessons on common insects, chiefly such as are either useful or injurious to man.

Part iii. deals with classification, and gives a concise outline of the different groups of insects; this is the most useful portion of the book. The names given to a good many insects in this part are, however, unfortunately not quite accurate; for instance, on p. 192 all the aphides, *rosae*, *humuli*, *mali*, &c., are put as belonging to the genus Aphis, which is not the case; nor is the name of the diamond-back moth *Plutella cruciferarum*, nor is that of the wheat midge *Cecidomyia tritici*; there may be an excuse for specific names being inaccurate, but surely not for generic ones.

Part iv. deals with the destruction and mitigation of insect pests; this is mainly compiled from American sources, the writer evidently being unacquainted with any work done in this country. Certainly here no one would dream of following the advice given on p. 246, "Paris green may be applied without danger at the strength of 1 lb. to 150 gallons of water." No mention is made of quassia wash or caustic alkali wash, so largely used in this country. The whole chapter is, in fact, but a poor account of the subject.

The work is illustrated with 103 figures, the majority good, but the reproductions of Bracy Clarke's bot-flies (Figs. 81 and 82) are scarcely recognisable; nor would anyone recognise the larva of the gooseberry saw-fly (Fig. 56), or the goat moth and its larva (Figs. 48 and 49).

To the pure entomologist the work will prove interesting and instructive reading, but it cannot be recommended to those who wish to study the economic side of the subject.

Chloroform: a Manual for Students and Practitioners. By Edward Lawrie, Lieut.-Colonel I.M.S., &c. Pp. 120. (London: J. and A. Churchill, 1901.) Price 5*s.* net.

THE book before us will be read with interest by those in whose memory the chloroform polemic is still green. It consists essentially of a physiological and clinical part. With regard to the former, Dr. Lawrie gives a history of the polemic between Drs. Gaskell and Shore and himself, extending from the first publication of the Cambridge physiologists upon this subject to the discussion at Toronto in 1894, in which, in the author's words, "the victory, which was decisive and permanent, rested with us." In addition to this historical sketch, the author gives certain experiments from the report of the Hyderabad Commission, some experiments made subsequently at Hyderabad, and some made by Prof. Rutherford upon the effect of stimulation of the vagus nerve during the inhalation of chloroform. These experiments are all illustrative of the action of chloroform upon the circulation, and are adduced by the author in support of the thesis that chloroform has no direct paralysing action upon the heart. The rest of the book is devoted mainly to the clinical aspect of the subject, the author entering fully into the technique of chloroform administration. Here he maintains strongly that the entire attention of the anæsthetist should be devoted to the respiration, and that no chloroform should be administered during struggling. The last chapter is devoted to the question of the statistics of chloroform and ether administrations. The author's statistics of chloroform show one death in 17,300 administrations; those of Mr. Roger Williams one death in 1236 chloroform and one in 4860 ether administrations.

Les Limites de la Biologie. Par J. Grasset. Pp. iv + 188. (Paris: Felix Alcan.) Price 2*f.* 50*c.*

PROF. GRASSET'S book is based upon a lecture he delivered at Marseilles in April of last year; we have here, however, not only the substance of that discourse, but numerous extracts from the writings of philosophers and men of science of many countries in support of the author's thesis. It is urged that biology is not the universal and unique science which some of its exponents claim it to be; and an attempt is made to describe its limitations. In separate chapters of his book, M. Grasset considers biology in its relation to the physicochemical sciences, to morality, psychology, æsthetics, sociology, mathematics, logic, metaphysics and theology. Whether the reader agrees with the conclusions or not, he will be interested in this exposition of the views of a medical man who believes there are parallel lines of progress along which human knowledge will continue to grow, and that these lines cannot from the nature of things intersect.

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.]*

Heights of Sunset After-glows in June, 1902

THERE was a very fine example of red sunset after-glow visible here on the evening of the 26th ult., which presented with rather remarkable appropriateness to the date of its appearance, as immediately occurred to me while watching the impressive sight, a scene of transcending splendour of nature's own elaboration which could hardly have been much surpassed in grandeur by what England's great display of rare illuminations on that night would undoubtedly have been, if a check most sorely sad and grievous had not interposed a throb of deep sorrow on the nation, eliciting good proofs of its heartfelt sympathy and loyalty so universally and strongly as to prevent those sumptuous light displays from being used as auspiciously as they were hoped to be to celebrate the joyfully expected "Coronation-day" of 1902. The sun set at about 8h. 25m. with its orange-yellow disc unhazed, and only shorn of rays by a few faint cirrus cloud-streaks close to the horizon, the sky being elsewhere apparently quite free from clouds. At about 8h. 40m. a long low belt of sky extending 70° or 80° along the north-west horizon had grown orange-yellow, streaked with a few faint lines of red and gradually diluted upwards at a height of 15° or 20° into pale shades of light yellow. A ruddiness of the sky in the east had at the same time risen nearly to the zenith, and through its natural blue tint there the sky passed gradually to white about half-way from the zenith to the west horizon, while under this white tract (about 30° in width) lay the bright belt of orange light with its shades of yellow gradually deepening downwards. But at about 8h. 45–50m. the pure white interval between the ordinary blue and the yellow-tinted regions was gradually invaded, and at last quite occupied, by the advancing ruddy colour from the east; and until about 8h. 55m. a space from 30° of altitude in north-west to near and somewhat beyond the zenith, and for 40° or 50° to either side of a vertical line through the place of sunset, presented a broad expanse of rich rose-coloured, lake-red light pervading all the sky's north-western quarter with a fine wide blaze, against the purple glare of which tall trees and houses all looked sharply silhouetted, and for a short space of about ten minutes that the rose-red colour lasted, all objects of the landscape facing towards the west looked conspicuously crimsoned. The ruby-tinted glow sank rather rapidly in height, and by 9 p.m. it had subsided into the summit of a lower and far brighter pinkish-orange bank of light about 30° high, the lower layers of which formed a belt 12° or 15° in height stretching for about 90° along the west-to-north horizon in a blaze of yellow amber or of ochre-yellow colour. No radiating streamers or shadow-beams crossed either the previous purple glow or this orange-reddish, dome-like bank of light; but the latter light-field's splendid flood of unflecked, evenly-spread colour sank very gradually, preserving its length, to 12° or 15° in altitude by 9h. 15m., growing less ruddy, and assuming pretty uniformly then throughout the horizon layer's yellow-ochre colour. As its brightness had then very sensibly diminished, no further watch was kept on its later changes of appearance.

The time of occurrence of the true rose-tinted glow, when the white space's illumination was replaced, and then swept down into the sunset-glow, by a westward coursing wave apparently, of rose-tinted light, was about 8h. 50–55m. when at its brightest, or about 25–30m. after sunset, when the sun was therefore about 3° below the horizon here, and when the earth's shadow-surface cast by the sun through the air above this point of view was about five miles from the earth's surface. The finely divided matter which by a red-bordered coronal or "Bishop's ring" effect[1] of diffraction, probably, on an exceedingly wide-circle scale, bent downwards into view from nearly overhead the sun's parting rays in the westward coursing way which seems to be quite general in these dust-caused colour-glows, and with red colour made rosy, probably, by mixture with the sky's ordinary blue, must thus, it appears, have been at no very considerably greater height in the atmosphere than about five miles; or at about the ordinary floating level of cirrocumulus and cirrostratus clouds.

A few less radiant after-glows of rosy tinge appeared here when the sky was clear, on June 17 and 21; but no perceptible traces of rose colour occurred in the pallid sunsets of June 23 and 25, although the sun went down on the latter date behind a faint low bank of cirrus cloud, surrounded by a splendid orange-yellow "glory" about 10° wide, very suggestive of "Bishop's ring," as it was shaded off by redder colour at its borders. As the last visible spark of the sun's bright orange body disappeared in a little cleft, apparently (for it lingered there for a second or two), of a tree-clad hill horizon four or five miles distant, it was white (and the same was noted on the 26th), and showed no greenish coloration.[1] Under the north-western edge of a thick cloud-veil which overspread the sky on Sunday evening, June 22, a belt of sky about 40° long and about 10°–15° high was brilliantly ablaze, from 9h. to 9h. 15m., with light of orange-yellow colour slightly streaked with red, and presented, among fragments of dark cloud dispersed across it, an almost terrifying resemblance to reflection in the sky of an immense distant conflagration. On June 24 a ruddy yellow glare widely pervaded the clear sky to a high altitude in N.W. from 8h. to 8h. 30m., but I was not fortunate enough among obstructions of its view in London to obtain any observations of its changes. On two other evenings, however, Friday and Saturday, June 27 and 28, sufficiently clear views of the rose-tint were seen, the times of apparition of which were recorded, to afford additional determinations of the real height of its appearance; and the following are some details of the pink glow's aspect on the three or four dates besides June 26 when its successive changes here were pretty clearly recognised and were approximately noted.

On June 17, the first clear evening after a cold, rainy fortnight, a pale cochineal tint, in the north-west, of the beautifully transparent sky was first quite plainly noticed, at 9h. 10–15m., of some width and at an altitude of about 10°–30°; although a similar, but rather weaker, pink glow had already before been seen with rather less distinctness on the last two nights of May; and on this evening it faded out by 9h. 15m., sinking down into a brick-red light-glare 5°–10° high, which by about 9h. 20-25m. grew dull orange-yellow and then faded. The first commencement of the glow was not seen, but as it was probably near its

[1] The ring was thus described by Mr. S. E. Bishop, at Honolulu, in NATURE (vol. xxix. p. 260, 1884, January 17):—As "a very peculiar corona or halo extending from 20° to 30° from the sun, which has been visible every day with us, and all day, of whitish haze with *pinkish* tint shading off into *lilac* or purple against the blue . . . It is hardly a conspicuous object." In the growing dusk, however, of an hour after sunset, the ring of pinkish white and purple, probably produced by admixture of the sky's ordinary blue with the yellow, orange and red parts of a pure corona, however weakly visible in full daylight, might yet in twilight look bright enough to be easily distinguishable; and the gradual shrinking inwards of this distinct red bordered ring from nearly overhead towards the west as the remaining upper levels of the atmosphere still lighted by the sun's rays grow every moment loftier, must pretty surely indicate that the first red light to fade away, or that beginning nearly overhead and furthest from the sun, belongs at once to both the lowest and the finest-grained dust-layers of the corona-forming haze; a conclusion nowise inconsistent with a usually experienced property of mists that they most commonly become coarser-grained in retreating inwards from their borders.

[1] The earliest mention that I have seen of the "green-flash" at sunset, as having been sometimes observed on the sea horizon from Bude, in Cornwall, by the Rev. G. H. Hopkins (NATURE, vol. xxix. p. 7, 1883, November 1), concludes with a remark that the effect was not produced when the sun set behind a distant cloud, and that it might very probably be also seen at sunrise. This last conjecture was immediately confirmed (*ibid.*, p. 76) by Prof. W. Swan, who wrote from Edinburgh that when watching for sunrise on the Rigi, on the very clear morning of September 13, 1865, he saw the sun appear with a dazzling blaze, for the first instant, of superb emerald green colour, from behind the sharp outline of a distant mountain. It may be interesting to add here, with respect to the other condition noticed by Mr. Hopkins, of the green flash not being apparently produced by the sun's descent behind a cloud, that having been myself, with three others (two of us using binocular field-glasses), well placed on April 22 last for trying to observe the totally eclipsed moon in the east and the setting sun in the west above the horizon together, the sun at least, after a cloudy and rather stormy day, set in an opening of clear sky, behind a low bank about 2° or 3° high, of sharply edged, opaque and solid-looking cumulus which, judging from the ten miles distant ridge of hills at Cookham, very far behind which the cloud-bank seemed to lie, could hardly have been less than 20 or 30 miles from our position. Passing the word to "look out for colour," when the sun's upper limb was nearly disappearing, we all exclaimed "green!" together, as the last and most northerly light-speck of three bright beads into which the sun's upper limb broke up at last lingered for not much more than half a second after the other two, both of which looked rather whiter than the last, when fading, and then vanished. Of the last spark's distinctly green colour there could be no doubt, and it inclined rather to a yellowish than to a blue shade of green. A thin thread of yellow light, like an extremely slender, short, crooked horizontal lightning flash, fringed the dark cloud's upper edge for a few minutes, behind which, at about 7h. 15m., the sun had descended; and beyond that the clear sky was nearly grey, and until about 7h. 30m., like the sun's disc itself, very free from yellow and orange sunset colours.

brightest at 9h. 10m., 45 or 50m. after sunset, when the sun would be 5¾° below the horizon, its real height above the earth, making proper allowance for its low altitude of 20° and for the sunlight's refraction, was about 13 miles; while its low angular distance from the sun probably denoted a not very excessive fineness of the sunlit haze material.

On June 21, at 8h. 53–56m., or about 30m. after sunset, a wide expanse of pink glow was seen in the upper parts of three broad streamers radiating not far from vertically upwards, to altitudes of about 30°, from the sun's place. The streamers sank in altitude to about 20° by 9h., and subsided gradually by about 9h. 5m. into the summit of a ruddy yellow light belt extending about 90° along the horizon in the sunset quarter to altitudes of 8°–15°. This bright tract grew duller yellow and orange at its base and borders, until about 9h. 20–25m., when it had nearly faded out. At 30–35m. after sunset, when the streamers' crests at an altitude of 20–30° glowed visibly with rosy light, the sun was 3½° or 4° below the horizon here, and the height of the red coronal glow produced there by the sun's parting rays must have been about 6½–8½ miles above the earth.

For nearly half an hour after sunset on June 27, the clear north-western sky showed only weak dull shades of yellow, but a long low belt of this at the horizon attained some intensity at 8h. 45–50m., when a short arched band of level cloud streaks grew pink at first and then bright crimson on their lower edges, and from 8h. 50m. to 9h. presented there a splendid interlacing network of red stripes about 35° long and 4° high. At the latter hour pink streamers radiating from the hidden sun as centre and springing chiefly from the northern upper portion of the yellow light belt began to be visible, two immensely long and very narrow straight ones leaving it at about N.N.W., altitude 8°, with slopes of 15°–20° from horizontal, and reaching out, 3° or 4° apart, through 53° or 60° to somewhat beyond N.N.E., ending at altitudes there of 15°–20°. The upper and stronger one was pink towards its end, but where they joined the light belt most brightly, and passed through north at altitudes of about 10°–12°, they partook of the light belt's reddish yellow colour; above them some much shorter and weaker pinkish streamers soon appeared, and at about 9h. 15m. two rather tall wide patches of faint rosy pink were formed at an altitude of 25° or 30° above the sunset place, by two nearly vertical wide streamers, and remained visible with pink colour for some minutes. While travelling here by train from London during its appearance, I could not note the early stages of this glow's commencement, and my whole view of it was very partial; but from the pink tint's visibility from 9h. to 9h. 15m. at an altitude of about 20°–30°, at about 40 or 50m. after sunset here, when the sun was 4¾°–6° below the horizon, the heights of the pink crests of the radiating streamers would seem to have been, not very accurately, about 12½–20 miles above the earth.

A most complete view, however, of the successive features of the purple glow was obtained here on the evening of Saturday, June 28, when the concluded height of its appearance so surprised me by its unexpected lowness as to lead me to examine also the foregoing observations with a view to a general comparison together of the glow's real heights that would be found to be derived from my notes of it on different evenings. The sky was then streaked with cirrostratus cloud-seams ruling it with fan-like convergence towards about the sunset quarter; but except in that direction those fleecy stripes dispersed by about 8h. 40m., and the nearly clear north-western sky half-way to the zenith was pale yellow, passing above about that altitude into greyish white, and beyond the zenith into blue. At 8h. 50–53m., the yellow sky-zone's colour having deepened and the grey-white tract above having descended to about altitude 40°–45°, the latter space grew rapidly rose-pink and round its centre a nearly circular field about 40° in diameter displayed pale pink oleander-flower or almond-blossom colour. Ending upwards, under this, in light straw-yellow, lay the wide-arched summit of a pretty strong horizon glow about 20° high over the sun's place and about 30° long in span to either side of it, of ochre-tinted yellow. The rose-pink coloured space sank gradually, or died out from above, between 8h. 55m. and 9h., replaced from behind by greyish and blue sky and invading the pale straw-yellow summit of the arched horizon-glow, which together with that whole glow, by about 9h. 5m., grew orange-red throughout. This litharge-red, and a little while later fan-tail-looking, glow contracted slowly downwards until 9h. 15m., when as it was growing dim and inconspicuous I ceased to watch it. But in the last 10m. its upper border had in its usual way, when beginning to grow red, broken up into bright radial streamers crossing what remained visible of the cirrus streaks at such appreciable angles as to show them to be true solar light-beams quite unconnected with the wind-imparted radiation of those cloud-streaks from a near neighbouring but different focal centre. Where a long and well-defined straight radial streamer shooting up obliquely southwards crossed some of those faint cloud-streaks' strongest ripples, their gauzy cloud materials certainly did not add to its brightness; but at the same time they diminished the streamer's light so much less than that of the grey sky immediately adjoining it, that they could hardly be said to have very distinctly screened and darkened it.

As the sun's parting illumination of the sky with rosy colour, from altitude about 50°–60°, downwards, in this sunset, occurred (at about 8h. 55m.) not much more than 30m. after sunset here, when the sun was 3½° below the horizon, it would follow that this red illumination by direct sunbeams, of microscopically fine haze matter took place at about 7½ miles above the earth, or apparently not far from about the probable real heights of the simultaneously noticed cirrostratus cloud-streaks.

The chief features of these recent after-glows having been just the same as those which were generally noticed during the gradual subsidence of the volcanic after-glow appearances in 1883–4, since it was then pointed out by some investigators of their real heights that some white cloud-wisps looking phosphorescently bright long after dark, and even sometimes, near the horizon in the north, throughout the night, must have been floating far above the ordinary height limits of rain and snow clouds produced by aqueous vapour, I was led by the comparative lowness of these few new height conclusions to consult the original accounts given in NATURE by many good observers of the sky-glows in 1883–4, to recall more exactly than I could certainly remember what real heights had then been actually assigned to them. In such letters as Mr. F. A. R. Russell's, at Haslemere (NATURE, vol. xxix. p. 55), describing the evening sky-glow on November 9, 1883, as having twice pervaded the sky with rosy red, beginning from overhead, first at 5h. and again at 5h. 40m. (or at 42m. and at 1h. 22m. after sunset at 4h. 18m.), and as having gradually settled down into the greenish-yellow glare at the horizon in about 20–25m., it is quite evident that much loftier heights of the pink glow were then indicated than those which have just now again been essayed to be determined. The sun, at these two glows' commencements, would be about 5¾° and 11½° below the Haslemere horizon, and the corresponding vertical heights over Haslemere of its earth-grazing beams would, allowing about ½° for their downward deflection by refraction, be about 17 and 75 miles above the earth.

In letters from Mr. J. E. Clark at York and from Mr. J. Ll. Bozward at Worcester (*ibid.*, pp. 130–131), the sky-glows from November 27 to December 4, 1883, were similarly described, in general, as usually attaining their strongest and brightest redness about one hour after the time of sunset, with durations afterwards of the fiery-looking dying-out phase of the glow for nearly an hour longer. Although these observations were not made with certain enough discrimination of the exact times of the rose-red tints' commencements to afford very definite determinations of their real heights, yet in their records of about one hour after sunset, at which the whole height and width of the sky assumed an especially imposing kind of red magnificence, they were for the most part pretty perfectly accordant. At an hour after sunset on December 1, the sun would have sunk about 7° below the horizons of York and Worcester, and the height above the earth of fine dust-haze beginning to shine then overhead with red illumination would be about 25 miles. But determinations of the pink glow's real height by the method which has here been used, and of the warrantableness of which the roseate displays' frequent collection into tufted heads of real sheaf-like sunbeam radiations is itself a sufficient proof to afford us full assurance, were in fact actually obtained on November 25–26 and 29, 1883, and were communicated in letters (*ibid.*, p. 103 and p. 130) by Annie Ley, at Ashby Parva, Leicestershire, and by R. von Helmholtz, in Berlin, who concluded it to have been at upwards of 13 and at about 40 (? more nearly 30) miles high respectively. The intervals after sunset when the wide red glow began in these two latter cases were about 50–60m. and a little more than one hour, resembling the generality of other observers' records, in those

most gorgeously coloured, long-enduring sunsets, of the times of the conspicuous red glows' commencements; but this average interval appreciably surpassed the shorter space of 25–50m. (as did also the fading-out duration of nearly an hour exceed that of only 20-25m.) observed in last month's displays; and the computed heights accordingly of the glow-producing matter ranged considerably lower (from 5 or 8 to 13 or 20 miles) in these latter than in the memorable sunset glows which followed the great eruption in Java on August 27, 1883, when heights appear to have been found of 13 or 17 to 25 or 30, or even possibly of 40 or 70 miles, for the strata of the atmosphere contaminated with volcanic dust.

The relative height results and the comparative intensities of the present and of the former glow displays seem, however, to have been in quite naturally comprehensible agreement with the lower height of projection, and with the generally lesser magnitude of the recent fearfully destructive outburst on the islands of Martinique and St. Vincent, when compared with the terrifically violent and immense volcanic explosion of Krakatoa in August, 1883, which is generally admitted to have had no previous parallel, in respect of scale and violence of mountain-mass ejection, in the history of such terrestrial convulsions. It will be interesting to notice on future nights if more examples of rose-red coloration should occur, when the times of the white and yellow sky-tracts becoming pink and ruddy should be noted, as the past month's rosy and fire-tinted sunsets were perhaps not quite sufficiently conspicuous to establish their certain connection with the terrible volcanic catastrophe of May 7-8 last in the West Indies. But considering the low temperature and continued cold soaking rainfall during all the early part of last month, until Sunday, June 22, it seems far from easy to conceive that the strikingly fine sunset display of Thursday, June 26, and the conspicuously rosy colorations of the sunset sky on June 27 and 28 can by any possibility have been merely sunset glares produced by ordinary floating dust raised locally from parched or arid tracts of land by the heat and fresh east wind of those few days of the first short interval of summer warmth and sunshine in last month, on which they were observed.

Observatory House, Slough, July 10. A. S. HERSCHEL.

P.S.—July 16.—A very fine display of orange-reddish streamers diverging in an open fan of six or seven stately light-beams from a similarly coloured horizon glow, 6° or 8° high at their common base where the sun had set (at about 8h. 15m.), was seen here on Monday evening, July 7. From 8h. 50–55m., when these fiery-looking beams began to appear, up to altitudes of about 35°, across a rosy tract of sky which had sunk to the elevation of their growing crests from a higher region of pink colour first distinctly well perceived at 8h. 42–44m., their radiant light-sheaves shortened gradually without change of place or brightness; and they lasted thus quite 20m., retreating slowly into the decreasing glow at the horizon until that glow itself, at last, grew quite low and dull at 9h. 15m. The pink glow's lower border, when the first bands of streamers crossed it, was not more than 10° or 12° from the horizon, and the glow's red hue soon permeated all the yellow belt of sky which lay below it, while the streamers, at their heads, grew orange-red in place of pink, and thus from 8h. 50–55m. onwards, the whole display, until it subsided, was of one bright pinkish-orange tint in all its features. The new moon's very slender crescent, at 8h. 55m., lay less than 1° from the horizon, under the end part of the most southern streamer, looking pure yellow, and showed by its clear visibility how free from mist and smoky haze the sky was on that evening quite close to the horizon.

From the pink glow's first appearance at 8h. 43m. with an altitude of about 35°, at about 28m. after sunset, the resulting real height of the layer of dusty air which was thus lit up by the sun's departing rays, could not much exceed 5 miles above the earth's surface. On other dates in July before and since that notable appearance, the observed occurrences of a pink tinge in the sunset sky were scarcely noticeable, and the estimated time of its first appearance was only once thought to be pretty certainly trustworthy, on Sunday, July 13. A rosy tinge then first presented itself pretty brightly at 8h. 41m., about 33m. after sunset, at about altitude 40°, sinking down along the heads of some nearly vertical wide streamers, in three or four minutes to altitude 15°–20°, where it soon died away. The height of the mauve-coloured haze-stratum in the atmosphere which this observation pretty nearly indicated would seem to have been about 7 or 8 miles.

In addition to the above short notes of some particular accounts contained in NATURE of the bright sky-glows of November and December, 1883, it was observed, I find also, by Mr. E. Douglas Archibald, at Rusthall, near Tunbridge Wells (NATURE, vol. xxix. p. 176), that after sunset (at about 3h. 51m.) on December 6, a bright silky-looking white space in the clear sunset sky changed to pink at 4h. 25m. (34m. after) and to red at 4h. 45m. (54m. after sunset), which would imply heights of the pink and red glows of about 8 and 21 miles above the earth. But from the appearance of the glow on December 7 and of its reflection on low clouds, Mr. E. D. Archibald remarked that the red light's long continuance after the pink glow's departure was mainly attributable to cloud or haze reflections of true red coronal glares about the sun; and the conspicuous tinging of the white space with pink or rosy iridescence he concluded, from the interval between the concluding glow of ordinary cirrus and the commencing glow of the loftier dust stratum, corresponded more nearly with a height of from 10 to 13 miles, than with the great height of 40 miles assigned to the glow (probably from long-lasting reflection of red glows in the west on low-lying clouds, or perhaps even on the high dust stratum itself) by Prof. von Helmholtz.

Distribution of Pithophora.

IN your Notes of July 17 you state that Mr. Kumagusu Minakata wishes to know if any species of the genus Pithophora besides *P. Kewensis* has been reported from any part of the Old World except Japan since 1877.

P. radians, West and G. S. West, was described from Loanda, on the west coast of Africa, in *Journ. Bot.* (January, 1897, p. 36), and has more recently been found in Ceylon (cf. *Trans.* Linn. Soc., bot. ser. 2, vol. v., 1902, p. 132). *P. Reineckii*, Schmidle, was described from Samoa in Engler's *Bot. Jahrb.* (xviii., 1896). Schmidle has also described at least one other species from the Old World, but I have not the reference to hand. It will be found within the last five years either in Engler's *Bot. Jahrb.* or in "Hedwigia." G. S. WEST.

Royal Agricultural College, Cirencester, July 18.

Saturn Visible through the Cassini Division.

IN NATURE of May 22 you were good enough to publish my prediction that, on July 17, the Cassini division of Saturn's ring would be invisible where it crossed the planet.

On July 15, Mr. Townshend, president of the Leeds Astronomical Society, reports that he saw the division throughout the ring and crossing the globe, but that on the 17th the portion crossing the globe was invisible. Mr. Townshend observed with a 10-inch reflector, and is a very competent observer.

On July 17 I was observing with a 9-inch refractor, and the Cassini division, clearly seen in the ansæ of the ring, was quite invisible in that part of the ring which crossed the globe.

I shall be very glad to receive notes of other observations of Saturn made on July 17, and shortly before and after that date.

Invermay, Leeds, July 21. C. T. WHITMELL.

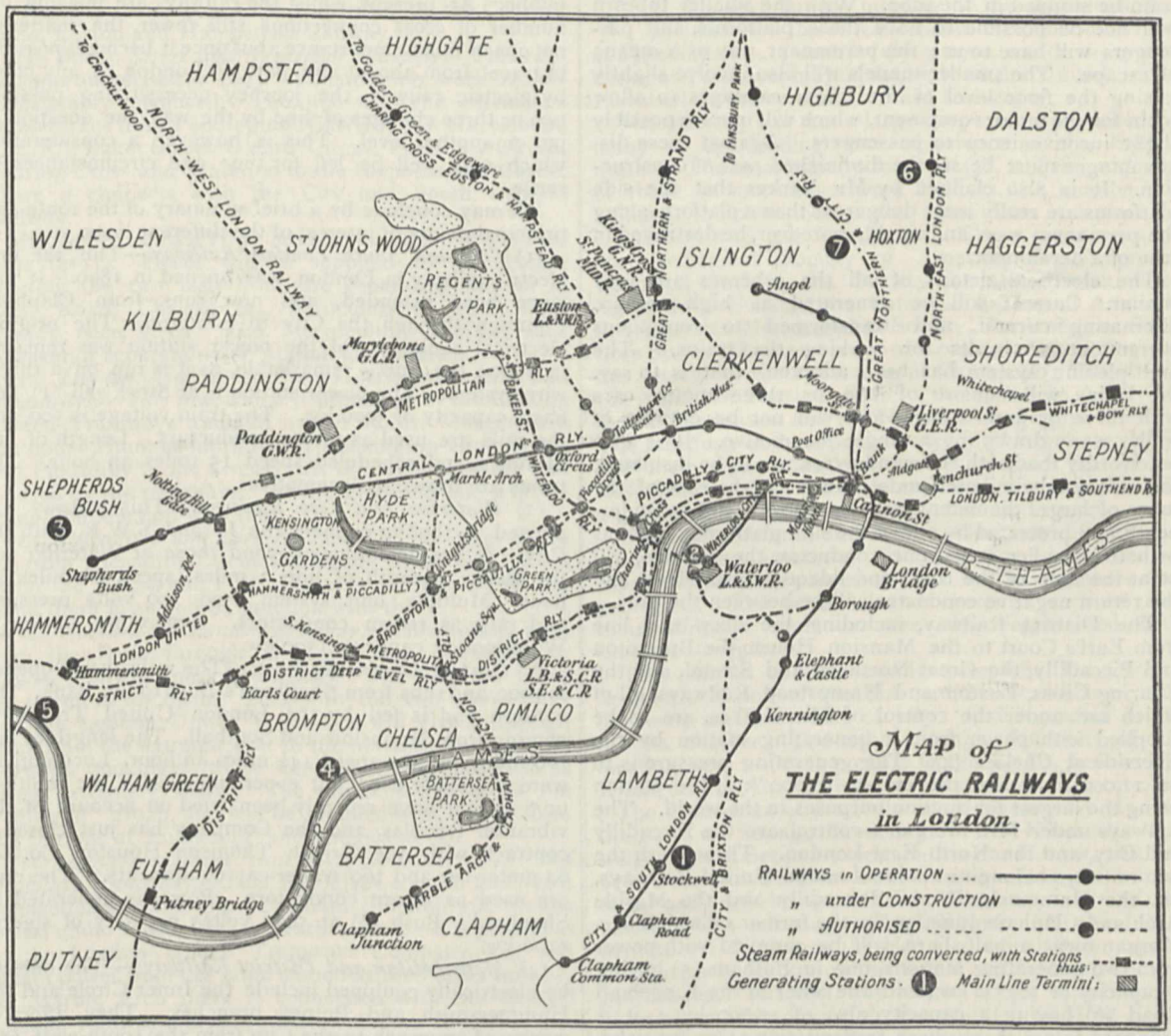
THE ELECTRIFICATION OF LONDON.

THE various electric railway Bills which have already passed through the House of Lords came up for second reading in the House of Commons last week. In spite of some attempts to reject several of these Bills they all successfully passed the second reading and have been referred to two Select Committees of the House of Commons. These Committees, each of which will deal with about half-a-dozen Bills, are to hold their first meetings at once, the one under the chairmanship of Sir L. M'Iver, the chairman of the other being Mr. Seale-Hayne.

The Bills have already been thoroughly investigated by the Select Committees of the House of Lords presided over by Lord Windsor and Lord Ribblesdale during April and May. These two Committees had much the more arduous task, as they had to deal with a larger number of Bills, several of which they rejected. It is possible, as a result of their work, to form some idea of

the probable effect of the proposed new railways in relieving the congested London traffic. It will be understood that it is assumed in the following article that the Bills which have passed the House of Lords will also pass through the Commons without any modifications of the first importance. In all, no less than twenty-four different Bills have come before Parliament this session relating to electric railways in London; of these eighteen were for new railways or extensions of authorised routes, one was for power to run an existing steam railway electrically, and the remaining five for extension of time for construction. The extension of time was in all cases granted, but it seems that the number of instances in which it was applied for had a notable effect on the decisions of the Committees with regard to other schemes. For it was the difficulty in raising the necessary capital which made application for extension of time necessary, and, as a result, where new railways were promoted the Committees required evidence that the promotion was financially well backed before sanctioning the lines. Of the eighteen Bills for new railways, many were directly in competition for the same route, so that it was inevitable that some should be rejected. Thus there were three different companies promoting Bills for a railway connecting Hammersmith with the city, one of these being the Central London Railway, which proposed to run the new line as a "circle" in conjunction with their existing route. This Bill was, however, rejected, the successful competitor being the London United Tramways and the Piccadilly and City and North-East London Railways, will provide a through route from the extreme west to the north-east of London.

From the map which we publish in illustration of this article, the references to different railways will be easily understood. For the data for this map we are largely indebted to the excellent maps published from time to time in the *Electrician*. It shows only those lines the construction of which has been authorised (or which are in operation), and a different system of drawing has been adopted to indicate which railways are working, which under construction and which merely authorised. The engineering details, so far as they are yet decided, show a remarkable uniformity, resulting partly from the decisions of the Board of Trade, the Vibration Committee, &c., which have recently been given in connection with different difficulties arising in the construction and working of "tube" railways. Most of the new railways will be "tubes." The Hampstead-Edgware line, which is to be about 6 miles long, is to run in the open; it forms a continuation of the Charing Cross, Euston and Hampstead Railway shown on the map; so also will a few miles of



the northern end of the North-East London Railway which runs past Tottenham to Palmer's Green. Of course, also the Metropolitan and District Railways and the London, Tilbury and Southend Railway (which is authorised to convert to electric traction) will not run in tubes. In some of the railways the proposed diameter of the tube is 11 feet 6 inches, and in the others two feet larger than this, Mr. Yerkes favouring the smaller diameter for the railways under his control. The larger diameter allows of the construction of two platforms, one on either side of the train, for the use of passengers in case of an accident. These, with the electric lighting of the tunnel which it is proposed to carry out, will afford an easy means of getting to the nearest station should a train be stopped in the tube. With the smaller tubes it will not be possible to have these platforms, and passengers will have to use the permanent way as a means of escape. The smaller tunnels will also involve slightly raising the floor level of the motor carriages to allow room for the motor equipment, which will involve possibly slight inconvenience to passengers. Against these disadvantages must be set the diminished cost of construction. It is also claimed by Mr. Yerkes that the side platforms are really more dangerous than a platform along the permanent way, and would, moreover, be destroyed in case of a derailment.

The electrical details of all the schemes are very similar. Current will be generated as high-pressure alternating current, and transformed to continuous current at 500 volts for working the trains. The multiple-unit system has been adopted—that is to say, the trains will consist of two or three motor cars with three or four trailers, and will not be entirely of trailer cars drawn by a single locomotive. It is also noteworthy that both the conductors are to be insulated, the rails not being used as a return; in the case of the tubes of larger diameter, both conductors will be underneath and protected by one of the side platforms, whereas with the smaller tubes, one conductor, the positive, will be at the side of the track and adequately shielded and the return negative conductor will be between the rails.

The District Railway, including the deep-level line from Earl's Court to the Mansion House, the Brompton and Piccadilly, the Great Northern and Strand, and the Charing Cross, Euston and Hampstead Railways, all of which are under the control of Mr. Yerkes, are to be supplied with power from a generating station by the riverside at Chelsea (4). The generating pressure is to be 11,000 volts and the output 50,000 kw., the station being the largest for traction purposes in the world. The railways under Mr. Morgan's control are the Piccadilly and City, and the North-East London. These, with the two railways belonging to the London United Railways, viz. the Hammersmith and Piccadilly and the Marble Arch and Clapham Junction, in the former of which Mr. Morgan owns a half share, will be supplied with power from two generating stations, one in Fulham (5) having a capacity of 12,000 kw., and the other in the Kingsland Road (6) having a capacity also of 12,000 kw.; it is proposed to use three-phase transmission at 10,000 volts.

It will be seen from the map that although, on the whole, London will be very well supplied with rapid transit facilities when all the new railways are working, there are still some districts inadequately catered for. It must, however, be remembered that in many of these districts there are good tramways either running, or to be run, electrically. Thus, in the south-east corner of the map, the network of tramways is fairly comprehensive. In the north-west the Middlesex county light railways will help to bring traffic to the city. A tube railway for the north-east, connecting Waltham Abbey and Walthamstow with the city, was withdrawn owing to certain alterations in the city end of the route, but it is understood that a similar line will be promoted next session. Indeed, one cannot help feeling that there are for the present a sufficient number of railways in hand, especially when it is considered how many are being financed by the same people; it will be time enough when these are either running or well advanced in construction to promote other Bills for the more complete electrification of London.

The question of fares and through booking is likely to become of importance when all the railways are at work. At present opinion seems divided between the system of the Central London Railway and the more usual booking system. It would certainly seem that when the whole network is complete a through booking arrangement would be a great convenience to the travelling public. At present, whilst the railways are few and the number of cross connections still fewer, the matter is not one of much importance; but once it becomes possible to travel from almost any part of London to any other by electric railway, the journey necessitating possibly two or three changes of line by the way, the question is put on another level. This is, however, a consideration which may well be left for time and circumstances to settle.

We may conclude by a brief summary of the route and principal points of interest of the different lines.

(1) *City and South London Railway.*—This, the first electric railway in London, was opened in 1890. It has since been extended, and now runs from Clapham Common through the City to Islington. The original electrical equipment of the power station was replaced in 1900; the line is remarkable, as it is run on a three-wire system. The power station is at Stockwell (1), and has a capacity of 3000 kw. The train voltage is 500, and the rails are used as return conductors. Length of line 6¼ miles, and scheduled speed 15 miles an hour. The trains are drawn by locomotives.

(2) *Waterloo and City Railway.*—This railway was opened in 1898 to connect the L. and S.W.R. with the City. It has no stations beyond those at Waterloo and the Bank. Length of line 3 miles, speed 18 miles an hour. Multiple unit system used, 500 volts pressure, and rails as return conductors. Generating station at Waterloo (2), capacity 1300 kw.

(3) *Central London Railway.*—The railway was opened in 1900, and runs from Shepherd's Bush to the Bank. The western end is fed by the London United Tramways coming from Hounslow and Southall. The length of line is 6 miles and the speed 14½ miles an hour. Locomotives were originally used, but experiments with the multiple unit system have recently been tried on account of the vibration troubles, and the Company has just closed a contract with the British Thomson Houston Co. for 64 motor-car and 160 trailer-car equipments. The rails are used as return conductors. Power is generated at Shepherd's Bush (3) at 5000 volts; capacity of station 5100 kw.

(4) *Metropolitan and District Railways.*—The lines to be electrically equipped include the Inner Circle and the Hammersmith and Putney branches. They afford a means of approach to the City from the south-west, and also communication through various districts by means of the "Circle." The electrification will be completed in eighteen months or two years.

(5) *District Deep Level.*—This is to provide an express route from Earl's Court to the Mansion House running under the existing line. The line is authorised, but construction work is not yet begun.

(6) *Whitechapel and Bow Railway.*—This branch of the District Railways will be electrified with the rest; it affords connection with the London, Tilbury and Southend Railway at Bow.

(7) *Brompton and Piccadilly Railway.*—The line will run from South Kensington Station (District Railway) *viâ* Knightsbridge to Piccadilly Circus; the construction

work has just started. An extension to Holborn has been granted, where (besides connecting with the Central London Railway) it will form a junction with the

(8) *Great Northern and Strand Railway.*—This will run from Finsbury Park (G.N.R.) past King's Cross and Holborn to the Strand.

(9) *Charing Cross, Euston and Hampstead Railway.*—Starting at the Charing Cross end, the line runs to Tottenham Court Road, where it gives a cross connection with the Central London, thence *viâ* Euston to Hampstead (Golder's Green) and Highgate. At the Golder's Green end there is to be a junction with the

(10) *Hampstead and Edgware Railway.*—This is to run in the open to Edgware. The line, which is outside the limits of the map, is to be controlled by the Charing Cross, Euston and Hampstead Railway.

(11) *Baker Street and Waterloo Railway.*—This railway was authorised in 1893. Construction work is now considerably advanced. The line with the extensions granted runs from Paddington (G.W.R.) *viâ* Marylebone (G.C.R.), Baker Street, Oxford Circus, Piccadilly Circus, Charing Cross and Waterloo to the Elephant and Castle, where it connects with the City and South London Railway.

Mr. Yerkes holds a large interest in all the above railways (4–11). Power will be supplied to all (except possibly the two last) from the generating station in Lots Road, Chelsea (4), particulars of which have already been given. The Metropolitan Railway has, however, a separate power station at Neasden.

(12) *London United Railways (Hammersmith and Piccadilly).*—This line, which is promoted by the London United Tramways and half owned by Mr. Morgan, will run under Hammersmith Road, Kensington High Street and Piccadilly to the Circus. At the Hammersmith end it is fed by the tramways. At the Piccadilly end it forms an end-on junction with the

(13) *Piccadilly and City Railway.*—This line is to run from Piccadilly Circus to Charing Cross, and thence under the Strand and Fleet Street to the Bank. At the Bank there is an end-on junction with the

(14) *North-East London Railway.*—This railway runs from the Bank through Highbury and Tottenham to Palmer's Green (near Southgate). The last few miles are to run in the open. This, with the two above lines and the London United Tramways, will give a through route from the extreme west to the north-east of London. Through booking is to be adopted, the proposed fares being extremely small. The group is known as the "Morgan" group, and will be supplied with power from the stations at Fulham (5) and Kingsland (6).

(15) *London United Railways (Marble Arch and Clapham Junction).*—This line gives a south and north connection running from Clapham Junction *viâ* Sloane Street under Hyde Park to Marble Arch. It is promoted by the London United Tramways Company, and will obtain power from the same station as their other railway. At Marble Arch there is connection with the Central London Railway and an end-on junction with the

(16) *North-West London Railway.*—This railway is to run under the Edgware Road to Cricklewood. The line was authorised in 1899, but construction work has not yet started. There are to be stations every half mile.

(17) *Great Northern and City Railway.*—An extension of this railway (which starts at Finsbury Park) to the Bank has been granted. The construction work is nearly completed. The generating station is to be on the Regent's Canal (7).

(18) *City and Brixton Railway.*—This line, which has been leased to the City and South London Railway, runs under the Brixton Road and connects Brixton with the City. Construction work has not yet commenced and details are not available.

(19) *London, Tilbury and Southend Railway.*—Powers have been granted to run the whole of this line electrically, but it is not proposed to do so until necessary. At first only such portions will be converted as are considered necessary to work in with the District Railway electrification. A site, large enough for a generating station for the whole line, has been acquired on the River Roding (a little beyond the limit of the map).

M. S.

THE PITTSBURG MEETING OF THE AMERICAN ASSOCIATION.

THE fifty-first annual meeting of the American Association for the Advancement of Science was held at Pittsburg, Pa., June 28–July 3, 1902, under the presidency of Prof. Asaph Hall, formerly of the United States Naval Observatory, and Harvard University.

The meeting was not a large one, but was attended by many of the leading men of science in the United States. The total registration was 436, and the majority of those in attendance were Fellows. A number of affiliated societies met at the same time and place in connection with the Association. These societies were the Geological Society of America, the American Chemical Society, the Society for the Promotion of Agricultural Science, the Botanical Society of America, the American Microscopical Society, the American Folk-Lore Society, the Association of Economic Entomologists, the Society for the Promotion of Engineering Education, the American Physical Society, the American Anthropological Association and the National Geographic Society. The meetings of these societies were all largely attended and their registration was not included in that of the Association, so that the Pittsburg meeting was practically a gathering of about one thousand scientific men.

As is quite natural, on account of its great mining and manufacturing interests, Pittsburg proved to be an especially attractive meeting-place for the engineers and geologists. The botanical and chemical sections and their affiliated societies were also represented with especial strength.

The address of the retiring president, Dr. Charles Sedgwick Minot, of the Harvard Medical School, was delivered on the evening of July 1 and is printed in full in this number. The other evening functions of the meeting were :—(1) A popular lecture by Dr. Leonard P. Kinnicutt, of the Worcester Polytechnic Institute, on "The Prevention of the Pollution of Streams by Modern Methods of Sewage Treatment." Dr. Kinnicutt is a well-known American expert in this line of work, and has been a careful observer of the experiments which have been and are being made in England, many of his lantern slides referring to English work. (2) On July 3 Mr. Robert T. Hill, of the U.S. Geological Survey, gave an illustrated lecture on the recent volcanic eruptions in Martinique. Mr. Hill was leader of an expedition to Martinique a few days after the eruption of Mont Pelée, other members being Prof. I. C. Russell, of Ann Arbor, Mich., and Commander Borchgrevink. The expedition was sent out by the National Geographic Society.

The vice-presidential addresses were as follows :—

Prof. James McMahon, of Cornell University, before the Section of Mathematics and Astronomy, on the subject "Some Recent Applications of the Function Theory to Physical Problems." Prof. D. B. Brace, of the University of Nebraska, before the Section of Physics, on the subject "The Group Velocity and the Wave Velocity of Light." Prof. H. S. Jacoby, of Cornell University, before the Section of Mechanical Science and Engineering, on the subject "Recent Progress in American Bridge Construction." Dr. B. T. Galloway, of the U.S. Department of Agriculture, before the Section of Botany, on

the subject "Applied Botany—Retrospective and Prospective." Prof. C. R. Van Hise, of the University of Wisconsin, before the Section of Geology and Geography, on the subject "The Training and Work of a Geologist." Prof. David Starr Jordan, of Stanford University, before the Section of Zoology, on the subject "The History of Ichthyology." Dr. J. Walter Fewkes, of the Bureau of American Ethnology, before the Section of Anthropology, on the subject "Prehistoric Porto Rico." Mr. John Hyde, of the U.S. Department of Agriculture, before the Section of Social and Economic Science, on the subject "Some Statistical and Economic Aspects of Preventable Diseases."

Certain important amendments to the constitution were made. The terms of office of secretaries of sections were lengthened from one year to five years. The council was given the power to add to its number nine Fellows whose terms of office shall be three years. The sectional committees were given greater permanency by provision for the election of one member each year who shall serve five years. All the recent changes in the constitution have aimed towards a greater permanency in the executive officers of the Association, of the council and of the sectional committees, and have increased the powers of the council.

The report of the treasurer and the financial report of the permanent secretary show the finances of the Association to be in a prosperous condition, and although they have by no means reached the standing of those of the British Association, the American Association is able this year to devote more funds to research grants. This year grants were made to committees on anthropometric measurements, the study of blind vertebrates, the relations of plants and climate, the atomic weight of thorium, and the determination of the velocity of light.

The next meeting of the Association will be held at Washington, from December 29, 1902, to January 3, 1903. The change in the time of meeting is a very important one and was made only after the most careful consideration. American universities and colleges have lengthened their Christmas holidays so as to enable the members of the scientific faculties to attend such winter meetings, and the week which contains the first day of January each year has been designated as "Convocation Week." Not only will the national scientific societies of the United States meet during this week under the auspices of the American Association, but the other learned societies of the country will also adopt this plan.

The president elected for the Washington meeting is Prof. Ira Remsen, the well-known chemist, recently made president of Johns Hopkins University. The vice-presidents of the different sections will be as follows:—Mathematics and Astronomy, Prof. George Bruce Halsted, of the University of Texas; Physics, Prof. E. F. Nichols, of Dartmouth College; Chemistry, Prof. Charles Baskerville, of the University of North Carolina; Mechanical Science and Engineering, Prof. C. A. Waldo, of Purdue University; Geology and Geography, Prof. W. M. Davis, of Harvard University; Zoology, Prof. C. W. Hargitt, of Syracuse University; Botany, Mr. F. V. Coville, of the U. S. Department of Agriculture; Anthropology, Mr. G. M. Dorsey, of the Field Columbian Museum, Chicago; Social and Economic Science, Mr. H. T. Newcomb, of Philadelphia, editor of *The Railway World*.

At the Washington meeting many additional societies will come into affiliation with the American Association, notably the American Society of Naturalists, with its group of special societies which have always held a mid-winter meeting, namely, the Society of Morphologists, the Society of Anatomists, the Society of Physiologists, the Society of Psychologists, the Society of Bacteriologists, the Society of Plant Morphologists, and others.

Address by Prof. C. S. Minot, President of the Association.

The Problem of Consciousness in its Biological Aspects.

OUR Association meets in Pittsburg for the first time. We are glad to indicate by our assembling here our appreciation of the immense work for the promotion of education and science which has been begun in this city and already is of national value. It has been initiated with so great wisdom and zeal that we expect it to render services to knowledge of the highest character, and we are glad to be the guests of a city and of institutions which are contributing so nobly to the cause of science.

We may congratulate ourselves on the bright prospects of the Association. Our membership has grown rapidly, and ought soon to exceed four thousand. Every member should endeavour to secure new adherents. For our next meeting we are to break with the long tradition of summer gatherings and assemble instead at New Year's time, presumably at Washington. To render this possible it was necessary to secure the cooperation of our universities, colleges and technical schools to set aside the week in which the first of January falls as "Convocation Week" for the meetings of learned societies. The plan, owing to the cordial and almost universal support given by the higher educational institutions, has been successfully carried through. For the winter meetings we have, further, succeeded in securing the cooperation of numerous national societies. The change in our time of meeting is an experiment, which we venture upon with the greater confidence because of the success of our present meeting in Pittsburg.

For my address this evening I have chosen the theme, "The Problem of Consciousness in its Biological Aspects." I hope both to convince you that the time has come to take up consciousness as a strictly biological problem, and also to indicate the nature of that problem and some of the actual opportunities for investigating it. It is necessary to begin with a few words on the philosophical interpretation. We shall then describe the function of consciousness in animal life, and consider its part in the evolution of animals and of man. The views to be stated suggest certain practical recommendations, after presenting which I shall conclude by offering an hypothesis of the relation of consciousness to matter and force.

Consciousness is at once the oldest problem of philosophy and one of the youngest problems of science. The time is not yet for giving a satisfactory definition of consciousness, and we must fain content ourselves with the decision of the metaphysician, who postulates consciousness as an ultimate datum or concept of thought, making the brief dictum *cogito, ergo sum* the pivot about which his system revolves. I have endeavoured vainly to discover, by reading and by questioning those philosophers and psychologists whom I know, some deeper analysis of consciousness, if possible, resolving it into something more ultimate.

Opinions concerning consciousness are many, and often so diverse as to be mutually exclusive, but they may be divided into two principal classes. The first class includes all those views which make of consciousness a real phenomenon, the second those views which interpret it as an epiphenomenon. We are, I think, practically all agreed that the fundamental question is, Does or does not consciousness affect directly the course of events? Or stated in other words, Is consciousness a true cause? In short, we encounter at the outset the problem of free-will, of which more later.

The opinion that consciousness is an epiphenomenon has gained renewed prominence in recent times, for it is, so to speak, a collateral result of that great movement of European thought which has culminated in the development of the doctrine of monism. Monism itself is postulated chiefly upon the two greatest discoveries of the nineteenth century, the law of the conservation of energy and the law of the evolution of species. Both laws establish a greater unity in the phenomena of the universe than mankind had previously been able to accept. In the physical world, instead of many forces we now recognise only one force,[1] which assumes various forms of energy, and in the living world we recognise one life, which manifests itself in many types of form. With these two unities in mind, what could be nearer than the thought that the unity goes still deeper,

[1] Force is used throughout this address as more likely to be understood by a general audience. It would be more correct to use "energy" in the sense in which the word is now applied technically in physics.

and that the phenomena of the inanimate or physical and of the living world are fundamentally identical? The progress of physiological science has greatly increased the impetus towards the adoption of this thought as the cardinal dogma of the new faith, because the work of physiologists has been so devoted to the physical and chemical phenomena of life that the conviction is widespread that all vital phenomena are capable of a physical explanation. Assuming that conviction to be correct, it is easy to draw the final conclusion that the physical explanation suffices for the entire universe. As to what is, or may be, behind the physical explanation, complete agnosticism is, of course, the only possible attitude. Such in barest, but I believe correct, outline is the history of modern monism, the doctrine that there is but one kind of power in the universe.

It is evident that monism involves the elimination of two concepts, God and consciousness. It is true that monists sometimes use these words, but it is mere jugglery, for they deny the concepts for which the words actually stand. Now consciousness is too familiar to all men to be summarily cast aside and dismissed. Some way must be found to account for it. From the monistic standpoint there is a choice between two possible alternatives, either consciousness is a form of energy, like heat, &c., or it is merely a so-called epiphenomenon. As there is no evidence that consciousness is a form of energy, only the second alternative is in reality available, and in fact has been adopted by the monists.

It is essential to have a clear notion of what is meant by an epiphenomenon. Etymologically the word indicates something which is superimposed upon the actual phenomenon. It designates an accompanying incident of a process, which is assumed to have no causal relation to the further development of the process. In practice it is used chiefly in regard to the relation of the mind or consciousness to the body, and is commonly employed by those philosophers who believe that consciousness has no causal relation to any subsequent physiological process.

For many years I have tried to recognise some actual idea underneath the epiphenomenon hypothesis of consciousness, but it more and more seems clear to me that there is no idea at all, and that the hypothesis is an empty phrase, a subterfuge, which really amounts only to this: we can explain consciousness very easily by merely assuming that it does not require to be explained at all. Is not that really the confession made by the famous assertion that the consciousness of the brain no more requires explanation than the aquosity of water?

Monism is not a strong system of philosophy, for it is not so much the product of deep and original thinking as the result of a contemporary tendency. It is not the inevitable end of a logical process, because it omits consciousness, but rather an incidental result of an intellectual impulse. Its very popularity betokens its lack of profundity, and its delight in simple formulæ is characteristic of that mediocrity of thought which has much more ambition than real power and accepts simplicity of formularisation as equivalent to evidence. It would seem stronger, too, if it were less defended as a faith. Strong partisans make feeble philosophers.

Consciousness ought to be regarded as a biological phenomenon, which the biologist has to investigate in order to increase the number of verifiable data concerning it. In that way rather than by speculative thought is the problem of consciousness to be solved, and it is precisely because biologists are beginning to study consciousness that it is becoming, as I said in opening, the newest problem of science.

The biologist must necessarily become more and more the supreme arbiter of all science and philosophy, for human knowledge is itself a biological function, which will become comprehensible just in the measure that biology progresses and brings knowledge of man, both by himself and through comparison with all other living things. We must look to biologists for the mighty generalisations to come rather than to the philosophers, because great new thoughts are generated more by the accumulation of observations than by deep meditation. To know, observe. Observe more and more, and in the end you will know. A generalisation is a mountain of observations; from the summit the outlook is broad; the great observer climbs to the outlook while the mere thinker struggles to imagine it. The best that can be achieved by sheer thinking on the data of ordinary human experience we have already as our glorious inheritance. The principal contribution of science to human progress is the recognition of the value of accumulating data, which are found outside of ordinary human experience.

Twenty-three years ago, at Saratoga, I presented before the meeting of this Association—which I then attended for the first time—a paper "On the Conditions to be Filled by a Theory of Life," in which I maintained that before we can form a theory of life we must settle what are the phenomena to be explained by it. So now, in regard to consciousness, it may be maintained that for the present it is more important to seek additional positive knowledge than to hunt for ultimate interpretations. We welcome, therefore, especially the young science of experimental psychology, which, it is gratifying to note, has made a more auspicious start in America than in any other country. It completes the circle of the biological sciences. It is the department of biology to which properly belongs the problem of consciousness. The results of experimental psychology are still for the most part future. But I shall endeavour to show that we may obtain some valuable preliminary notions concerning consciousness from our present biological knowledge.

We must begin by accepting the direct evidence of our own consciousness as furnishing the basis. We must, further, accept the evidence that consciousness exists in other men essentially identical with the consciousness in each of us. The anatomical, physiological and psychological evidence of the identity of the phenomena in different human individuals is to a scientific mind absolutely conclusive, even though we continue to admit cheerfully that the epistemologist rightly asserts that no knowledge is absolute, and that the metaphysician rightly claims that *ego* is the only reality and everything else exists only as *ego's* idea, because in science, as in practical life, we assume that our knowledge is real and is objective in source.

For the purposes of the following discussion we must define certain qualities or characteristics of consciousness. The most striking distinction of the processes in living bodies, as compared with those in inanimate bodies, is that the living processes have an object—they are teleological. The distinction is so conspicuous that the biologist can very often say *why* a given structure exists or *why* a given function is performed, but *how* the structure exists or *how* the function is performed he can tell very imperfectly—more often not at all. Consciousness is only a particular example, though an excellent one, of this peculiarity of biological knowledge; we do not know what it is; we do not know how it functions; but we do know why it exists. Those who are baffled by the elusiveness of consciousness, when we attempt to analyse it, will do well to remember that all other vital phenomena are in the last instance equally and similarly elusive.

In order to determine the teleological value of consciousness we must endeavour to make clear to ourselves what the essential function is which it performs. As I have found no description or statement of that function which satisfied me, I have ventured, perhaps rashly, to draw up the following new description:—

The function of consciousness is to dislocate in time the reactions from sensations.

In one sense this may be called a definition of consciousness, but inasmuch as it does not tell what consciousness is, but only what it does, we have not a true definition, but a description of a function. The description itself calls for a brief explanation. We receive constantly numerous sensations, and in response to these we do many things. These doings are, comprehensively speaking, our reactions to our sensations. When the response to a stimulus is obviously direct and immediate, we call the response a reflex action; but a very large share of our actions are not reflex, but are determined in a far more complicated manner by the intervention of consciousness, which may do one of two things, first, stop a reaction, as, for example, when something occurs calling, as it were, for our attention and we do not give our attention to it; this we call conscious inhibition; it plays a great *rôle* in our lives, but it does not mean necessarily that inhibited impressions may not survive in memory and at a later time determine the action taken; in such cases the potential reaction is stored up. Second, consciousness may evoke a reaction from a remembered sensation and combine it with sensations received at other times. In other words, consciousness has a selective power, manifest both in choosing from sensations received at the same time and in combining sensations received at different times. It can make synchronous impressions dyschronous in their effects, and dyschronous impressions synchronous. But this somewhat formidable sentence merely paraphrases our original description:—The function of consciousness is to dislocate in time the reactions from sensations.

This disarrangement and constant rearrangement of the sensations, or impressions from sensations, which we gather, so that their connections in time are altered, seems to me the most fundamental and essential characteristic of consciousness which we know. It is not improbable that hereafter it will become possible to give a better characterisation of consciousness. In that case the opinion just given may become unsatisfactory and have to yield to one based on greater knowledge. The characteristic we are considering is certainly important, and so far as the available evidence goes it belongs exclusively to consciousness. Without it life would have no interest, for there would be no possibility of experience, no possibility of education.

Now the more we have learned about animals, the better have we appreciated the fact that in them only such structures and functions are preserved as are useful or have a teleological value. Formerly a good many organs were called rudimentary or vestigial, and were supposed to be useless survivals because they had no known function. But in many cases the functions have since been discovered. Such, for example, were the pineal gland, the pituitary body, the suprarenal capsules and the Wolffian body of man, all of which are now recognised to be functionally important structures. Useless structures are so rare that one questions whether any exist at all, except on an almost insignificant scale. It has accordingly become well-nigh impossible for us to imagine consciousness to have been evolved, as it has been, unless it had been bionomically useful. Let us, therefore, next consider the value of consciousness from the standpoint of bionomics.[1]

We must begin with a consideration of the nature of sensations and the object of the reactions which they cause. In the simpler forms of nervous action a force, usually, but not necessarily, external to the organism, acts as a stimulus, which causes an irritation; the irritation produces a reaction. Within the ordinary range of the stimuli to which an organism is subjected the reaction is teleological—that is, it tends to the benefit of the organism. A familiar illustration is the presence of food in the stomach, which produces a stimulus, the reaction to which is manifested by the secretion of the digestive fluid for the purpose of digesting the food. An organism might conceivably be maintained solely by this mechanism, in cooperation with the physical laws, which govern all matter. Life in such an organism would be a succession of teleological processes, essentially mechanical and regulated automatically by the organism. By far the majority of biologists regard plants as essentially conforming to this type of life. Whether they absolutely so conform we do not, of course, yet know.

A sensation involves the interpolation of consciousness between the stimulation and the reaction, and in consequence there is established the possibility of a higher order of adjustment to the external world than can be attained through the teleological reaction to a stimulus. This possibility depends upon the fact that the intervention of consciousness permits an adjustment in accordance, not merely with the immediate sensation, but also and at the same time in accordance with earlier sensations. Thus, for example, the child sees an object, and its reaction is to take hold of the object, which is hot and hurts the child. Later the child sees the object again, and its natural reaction is to take hold of it again; but the child now reacts differently because its consciousness utilises the earlier as well as the present sensation; the previous sensation is dislocated in time and fused with the present sensation, and a new reaction follows. No argument is necessary to establish the obvious conclusion that an organism which has consciousness has an immensely increased scope for its adjustments to the external conditions; in other words, consciousness has a very high value for the organism. It is unnecessary to dwell upon this conclusion, for it will be admitted by everyone, except, perhaps, those who start with the *a priori* conviction that consciousness is an epiphenomenon.

A sensation gives information concerning the external world. Perhaps science has achieved nothing else which has done so much to clarify philosophy as the demonstration that the objective phenomena are wholly unlike the subjective sensations. Light is a series of undulations, but we do not perceive the undulations as such, but as red, yellow and green, or, as we say, colours; the colours give us available information, and we use them as so many labels, and we learn that reactions to these labels may be helpful or hurtful, and so we regulate our conduct. Objectively red, yellow and green do not exist. Similarly with the vibrations of the air, certain of which cause the sensation of sound, which is purely subjective. But the sound gives us information concerning our surroundings which we utilise for our teleological needs, although in nature, external to us, there is no sound at all. Similarly, all our other senses report to us circumstances and conditions, but always the report is unlike the external reality. Our sensations are symbols merely, not images. They are, however, bionomically sufficient because they are constant. They are useful, not because they copy the external reality or represent it, but because, being constant results of external causes, they enable consciousness to prophesy or foresee the results of the reactions of the organism, and to maintain and improve the continual adjustment to the external reality.

The metaphysicians have for centuries debated whether there is any external objective reality. Is it too much to say that the biological study of consciousness settles the debate in favour of the view that the objective world is real?

Consciousness is not only screened from the objective world from which it receives all its sensations, but also equally from immediate knowledge of the body, through which it acts. As I write this sentence I utilise vaso-motor nerves, regulating the cerebral blood currents, and other nerves, which make my hand muscles contract and relax, but of all this physiological work my consciousness knows nothing, though it commands the work to be done. The contents of consciousness are as unlike what is borne out from it as they are unlike what is borne in to it.

The peculiar untruthfulness to the objective, which consciousness exhibits in what it gets and gives, would be perplexing were it not that we have learned to recognise in consciousness a device to secure better adjustment to external reality. For this service the system of symbols is successful, and we have no ground for supposing that the service would be better if consciousness possessed direct images or copies instead of symbols of the objective world.

Our sensory and motor [1] organs are the servants of consciousness, its messengers or scouts, its agents or labourers, and the nervous system is its administrative office. A large part of our anatomical characteristics exists for the purpose of increasing the resources of consciousness, so that it may do its bionomic function with greater efficiency. Our eyes, ears, taste, &c., are valuable because they supply consciousness with data; our nerves, muscles, bones, &c., are valuable because they enable consciousness to effect the needed reactions.

Let us now turn our attention to the problem of consciousness in animals. The comparative method has an importance in biology which it has in no other science, for life exists in many forms, which we commonly call species. Species, as I once heard it stated, differ from one another with resemblance. The difference which resembles we term an homology. Our arm, the bird's wing, the lizard's front leg are homologous. The conception of homology, both of structure and of function, lies at the basis of all biological science, which must be and remain incomprehensible to any mind not thoroughly imbued with this conception. Only those who are deficient in this respect can fail to understand that the evidence is overwhelming that animals have a consciousness homologous with the human consciousness. The proof is conclusive. As regards at least mammals, I think we could safely say as regards vertebrates, the proof is the whole sum of our knowledge of the structure, functions and life of these animals.

As we descend the animal scale to lower forms there is no break, and therefore no point, in the descent where we can say, here animal consciousness ends and animals below are without it. It seems inevitable, therefore, to admit that consciousness extends far down through the animal kingdom, certainly at least as far down as there are animals with sense organs or even the most rudimentary nervous system. It is unsatisfactory to rely chiefly on the anatomical evidence for the answer to our query. We await eagerly results from psychological experiments on the lower invertebrates. A sense organ, however, implies consciousness, and since such organs occur among cœlenterates we are led to assign consciousness to these animals.

The series of considerations which we have had before us lead directly to the conclusion that the development and improvement of consciousness has been the most important—really the dominant—factor in the evolution of the animal series. The

[1] A convenient term, recently gaining favour, for what might otherwise be called the economics of the living organism. Bionomics seems preferable to *ecology*, which some writers are adopting from the German.

[1] And other organs in efferent relations to consciousness.

sense organs have been multiplied and perfected in order to supply consciousness with a richer, more varied and more trustworthy store of symbols, corresponding to external conditions. The nervous system has grown vastly in complexity in order to permit a constantly increasing variety in the time dislocations of sensations. The motor and allied apparatus have been multiplied and perfected in order to supply consciousness with more possibilities of adjustment to external reality, which might be advantageous.

If we thus assign to consciousness the leading *rôle* in animal evolution we must supplement our hypothesis by another, namely, that conscious actions are primary, reflex and instinctive actions secondary; or in other words, that for the benefit of the organism conscious actions have been transformed into reflexes and instincts. Unfortunately, we must rely chiefly on future physiological and psychological experiments to determine the truth of this hypothesis. Its verification, however, is suggested by certain facts in the comparative physiology of the vertebrate nervous system, which tend to show that in the lower forms (amphibia) a certain degree of consciousness presides over the functions of the spinal cord which in mammals is devoted to reflex actions. Its verification is further suggested by the natural history of habits. As we all know, new actions are performed with difficulty, and slowly, but if often repeated they are soon easier and more rapid. If a given reaction to a sensation or group of sensations through consciousness is advantageous to the organism, and the environment is such that the sensation is often repeated, then a habit is formed, and the response becomes more rapid ; and often in ourselves we see habits, which arose from conscious action, working almost without the participation of consciousness, and moreover working usefully, because rapidly. The usefulness of conscious reactions is that they are determined, not merely by the present sensation, but also by past sensations; but they have the defect that they are slow. We can readily understand that it would aid an organism to have the quicker reaction substituted, and we thus recognise a valid teleological reason for the replacement of conscious action by habits in the individual, by instincts in the race. The investigation of the evolution of reflexes and instincts is one of the important and most promising tasks of comparative psychology.

A frank, unbiassed study of consciousness must convince every biologist that it is one of the fundamental phenomena of at least animal life, if not, as is quite possible, of all life. Nevertheless its consideration has barely a place in biological science, although it has long occupied a vast place in philosophy and metaphysics. If this address should contribute to a clearer appreciation of the necessity of treating consciousness as primarily a problem for biological research to solve, my purpose will be achieved. In an ideal world philosophers and men of science would be identical ; in the actual world there are philosophical men of science and scientific philosophers ; but in the main the followers of the two disciplines pursue paths which are, unfortunately, distinct. The philosophical mind is of a type unlike the scientific mind. The former tries to progress primarily by thought based on the data available, the latter seeks to advance primarily by collecting additional data. The consequence of this difference is that philosophy is dependent upon the progress of science, but we who pursue the scientific way can make no greater mistake than to underestimate philosophy. The warning is needed. Data of observation are a treasure and very precious. They are the foundation of our mental wealth, but that wealth consists of the thought into which the data are transmuted. In pleading, therefore, for an increased observational study of consciousness we plead, not merely for science, but equally for philosophy. The scientific progress must come first. Hence we urge the advantage of investigating consciousness in its immediate revelations, which are accessible now. Let us give up the ineffectual struggle to discover the essential nature of consciousness until we can renew it with much larger resources of knowledge.

The psychologists ought now to apply the comparative method on a grand scale. They are just beginning to use it. Years of patient labour must pass by, but the reward will be very great. The psychic life of animals must be minutely observed, the conditions of observation carefully regulated, and the results recorded item by item. The time has passed by for making generalisations on the basis of our common, vague and often inexact notions concerning the habits of animals. Exact experimental evidence will furnish a rich crop of psychological discovery. Scientific psychology is the most backward in its development of all the great divisions of biology. It needs, however, little courage to prophesy that it will bring forth results of momentous importance to mankind. After data have been gathered, generalisations will follow which, it may be hoped, will lead us on to the understanding of even consciousness itself.

The teleological impress is stamped on all life. Vital functions have a purpose. The purpose is always the maintenance of the individual or of the race in its environment. The entire evolution of plants and animals is essentially the evolution of the means of adjustment of the organism to external conditions. According to the views I have laid before you, consciousness is a conspicuous, a commanding factor of adjustment in animals. Its superiority is so great that it has been, so to speak, eagerly seized upon by natural selection and provided with constantly improved instruments to work with. A concrete illustration will render the conception clearer. In the lowest animals, the cœlenterates, in which we can recognise sense organs, the structure of them is very simple, and they serve as organs of touch and of chemical sensation resembling taste. In certain jelly fishes we find added special organs of orientation and pigmented spots for the perception of light. In worms we have true eyes and vision. In vertebrates we encounter the true sense of smell. Fishes cannot hear, but in the higher vertebrates, that is from the amphibians up, there are true auditory organs. In short, both the senses once evolved are improved and also new senses are added. It is perfectly conceivable that there should be yet other senses, radically different from any we know. Another illustration, and equally forcible, of the evolution of aids to consciousness might be drawn from the comparative history of the motor systems, passing from the simple contractile thread to the striated muscle fibre, from the primitive diffuse nunculature of a hydroid to the highly specialised and correlated muscles of a mammal.

It is interesting to consider the evolution of adjustment to external reality in its broadest features. In the lowest animals the range of the possible adjustment is very limited. In them, not only is the variety of possible actions small, but they cover also a small period of time. In animals which have acquired a higher organisation, the adjustments are more complex both because the reactions are more varied and because they cover a longer period of time. Thus the jelly fish depends upon such food as happens to come within its reach, seizing from moment to moment that which it encounters ; but a lobster pursues its food, making complicated movements in order to reach and seize it. One can trap lobsters easily ; I doubt if one could trap a jelly fish at all. The next great advance is marked by the establishment of communication between individuals of the same species. About this phenomenon we know exceedingly little ; the investigation of it is one of the most important duties of the comparative physiologist. Its bionomic value is obviously great, for it allows an individual to utilise the experience of another as well as its own. We might, indeed, compare it with the addition of a new sense, so greatly does it extend the sources of information. The communication between individuals is especially characteristic of vertebrates, and in the higher members of that subkingdom it plays a very great *rôle* in aiding the work of consciousness. In man, owing to articulate speech, the factor of communication has acquired a maximum importance. The value of language, our principal medium of communication, lies in its aiding the adjustment of the individual and the race to external reality. Human evolution is the continuation of animal evolution, and in both the dominant factor has been the increase of the resources available for consciousness.

In practical life it is convenient to distinguish the works of nature from the works of man, the "natural" from the "artificial." The biologist, on the contrary, must never allow himself to forget that man is a part of nature and that all his works are natural works. This is specially important for the present discussion, for otherwise we are likely to forget also that man is as completely subject to the necessity of adjustment to external reality as any other organism. From the biological standpoint, all the work of agriculture, of manufactures, of commerce and of government is a part of the work of consciousness to secure the needed adjustments. All science belongs to the same category as the teleological efforts of a jelly fish or lobster. It is work done at the command of consciousness to satisfy the needs of existence. The lesson of all this to us is that we should accustom ourselves to profit by our understanding of the trend of evolution, which, in the progress humanity makes, obeys the

same law of adaptation to objective reality which has controlled the history of animals. This view of the conditions of our existence puts science in its right place. As all sensations are symbols of external reality useful to guide organisms to teleological reactions, so is all science symbolic and similarly useful.

Nature never produces what to us seems a perfect organism, but only organisms which are provided with means of adjustment sufficient to accomplish the survival and perpetuation of the species. Man also is imperfect, but in the struggle for existence wins his way because his consciousness has greater resources than that of any other organism. His great power arises from his appreciation of evolution. His highest duty is to advance evolution, and this duty must be most strongly felt by those who accept the religious interpretation of life. The advancement of science is an obligation. To this view of the work of our Association I may safely claim the assent of all present.

The function of science is to extend our acquaintance with the objective world. The purpose of the American Association is not alone to increase the sum total of science, but equally also to preach by word and precept the value of truth, truth being the correct conscious symbol of the objective, by utilising which our purposeful reactions are improved. The most serious obstacle truth encounters is the prevalence of what I may call "doll ideas," by analogy with the material dolls with which children play. The child "makes believe" with the doll, knowing all the time its unreality, assigns to it hopes, passions, appetites; the child may feel the intensest sympathy with its doll, weep at its sorrows, laugh over its joys, yet know always that it is a mere inanimate, senseless doll. Adult men and women have ideas, with which they play make-believe; doll ideas, which they know are unreal, and yet they mourn sincerely over the adversities of their mental dolls, rejoice over their successes and fight for them with passion. Such doll ideas become mingled with the real and inextricably woven into the fabric of life. They are treated with the most earnest seriousness. Men will fight for them as a child will fight for its doll, not because it is property, but because it is sacred personality. So are doll ideas often made sacred and defended with fanaticism. Yet behind, in consciousness, is the sense of unreality, the disregarded admission of "making believe." Do not doll-ideas—pseudo-opinions—play a great *rôle* in human life? I think they do, and thinking so, deem it all the more imperative that you and others should teach the people the standard of science, the humble acknowledgment of reality. I wish an impulse towards this goal from our Association could be imparted to every man and woman in the country, and I hope the Association may continue to grow in number and power for long years to come, as it has grown in the last few years, so that it shall be a national, all-pervading influence serving the truth.

It seems to me inconceivable that the evolution of animals should have taken place as it actually has taken place, unless consciousness is a real factor and dominant. Accordingly, I hold that it actually affects the vital processes. There is, in my opinion, no possibility of avoiding the conclusion that consciousness stands in immediate causal relations with physiological processes. To say this is to abide by the facts, as at present known to us, and with the facts our conceptions must be made to accord.

The thought which I wish to emphasise is the importance for the future investigation of consciousness of separating the study of what it does from the study of what it is. The latter study is recondite, metaphysical, and carries us far beyond the limits of verifiable human knowledge. The former study is open to us and offers opportunities to science, but it has hitherto been almost completely neglected. Biology has now to redeem itself by effectual researches on consciousness. On the adequate prosecution of such researches we base great hopes.

Before I close, permit me a few words concerning the relations of consciousness to the body, to the living substance through which it manifests itself. It is intimately linked to protoplasm. Probably no question is so profoundly interesting to all mankind as the old question, What is the relation of the mind to the body? It is a question which has been stated in many forms and from many points of view, but the essential object of the question is always the same, to ask whether consciousness is a function of living matter or something discrete and not physical or material.

Throughout this address consciousness has been viewed as a device to regulate the actions of the organism so as to accomplish purposes which on the whole are useful to the organism, and accordingly we have termed its function teleological. If this view is correct, it accounts for the limitations of consciousness, its mechanical mode of work, its precision and definiteness of action, for, of course, unless consciousness is orderly and obeys laws it cannot be of use to the organism, but, on the contrary, it would be harmful, and conscious animals would have ceased long ago to survive. The very fact that consciousness is of such high value in the bionomy of an animal renders it obvious that it must be subject to law. Accordingly it appears to us regulated as do the functions of protoplasm, hence to certain modern thinkers it presents itself as a function of protoplasm, or, as it may be better stated, as a state or condition of protoplasm.

The internal evidence of consciousness, however, is against this view and presents to us conscious actions as depending upon the consciousness. As before stated, I believe this evidence must be accepted. Now all the sensations of consciousness are derived from physical force, and all the acts of consciousness are manifested through physical force, hence if it has any real power consciousness must be able to change the form of energy. Unless we accept this doctrine we must give up all belief in free-will and adopt the automaton theory of life. Is not the more reasonable explanation that which is based upon all the contents of our consciousness rather than that which we can draw only by discarding the internal evidence which consciousness brings us? The hypothesis which I offer for your consideration is this:—

Consciousness has the power to change the form of energy, and is neither a form of energy nor a state of protoplasm.

By this hypothesis there are two fundamentally different things in the universe—force and consciousness. You ask why I do not say three, and add matter? My answer is that we do not have, and never have had, any evidence whatever that matter exists. All our sensations are caused by force, and by force only, so that the biologist can say that our senses bring no evidence of matter. The concept "matter" is an irrational transfer of notions derived from the gross molar world of the senses to the molecular world. Faraday long ago pointed out that nothing was gained and much lost by the hypothesis of material atoms, and his position seems to me impregnable. It would be a great contribution to science to kill off the hypothesis of matter as distinct from force.

To conclude, the universe consists of force and consciousness. As consciousness by our hypothesis can initiate the change of the form of energy, it may be that without consciousness the universe would come to absolute rest. Since I close with a bold speculation, let my last words recall to you that my text is:—Investigate consciousness by comparative observation. Only from observation can we know. Correct, intelligent, exhaustive observation is our goal. When we reach it, human science will be completed.

NOTES.

WE understand from recent Queensland newspapers that it has been determined to abolish the Weather Bureau of that colony as from the 30th ult., and that the services of Mr. C. L. Wragge and his special staff have been dispensed with. In a letter addressed by the Premier of Queensland to the Federal Prime Minister it is pointed out that this apparently retrograde step is owing to the urgent necessity for reducing in every branch of the public service the estimates of expenditure of the State, and that it is one of the "most unfortunate" results of the large deficit in the revenue, brought about by drought and other causes. Prior to federation, the Weather Bureau formed part of the Post and Telegraph Department of Queensland, and all telegrams and correspondence passed free. But during the last fifteen months the Federal Government has charged for these communications at the rate of about 4000*l.* a year, which expense cannot be borne any longer by the Queensland Government. The Premier writes that he feels sure the States in general will welcome any reasonable suggestions for a continuance of the work of the Bureau under federal control; we may therefore hope that the existing instruments and stations will be utilised, as far as practicable, in the interest of meteoro-

logical science. Truly the Colonies are in this respect following the mother country, and we may soon expect the Empire, so active in neglecting science, to be the laughing stock of civilised peoples.

THE Copenhagen correspondent of the *Times* reports that the International Conference for Biological and Hydrographical Research, the object of which is to promote ocean research for fishery purposes, was opened there on July 22. Dr. Deuntzer, Danish Foreign Minister, welcomed the delegates, who represented Great Britain, Sweden, Norway, Finland, Russia, Holland, Germany and Denmark. In reply to Dr. Deuntzer's welcome, the British delegate, Sir Colin Scott-Moncrieff, expressed the thanks of the delegates, who, he declared, earnestly hoped that their labours would have fruitful results. Herr Herwig, the German delegate, was elected president of the conference.

IT is stated that Prof. Virchow, who is now staying at Harzburg, is obliged to keep to his room owing to general weakness. His condition is causing uneasiness among his friends.

THE *British Medical Journal* announces that the King of Italy has given 10,000 lire to the Italian Red Cross Society in aid of the campaign against malaria in the Campagna this season. Prof. Postempski will, as formerly, act as director of the medical service organised under the auspices of the Society.

MR. E. B. BAILEY has been appointed a geologist on the Geological Survey of Scotland.

THE death is announced of Prof. Gerhardt, the well-known authority on diseases of the lungs and children's diseases, at his estate of Damberg, in Baden. Prof. Gerhardt, who was born in 1833, held professorships at Jena, Würzburg and Berlin, and was the author of several important medical works.

MR. BENJAMIN MARTELL, whose death we regret to see announced, for more than thirty years played a prominent part in the many important changes which have taken place during that period in connection with the development of ship construction in this country. He was born in 1825, and trained at Portsmouth Dockyard, where he served his time as an apprentice. He joined Lloyd's Register Society in 1856, and in sixteen years, after serving the Society at several of the important shipbuilding centres in the country, was called to the position of chief surveyor, which he held until his retirement in 1899. The tables of freeboard prepared by Mr. Martell, and afterwards placed upon the Statute Book, represent the results of one of the many pieces of work which he successfully carried out for the good of the shipping community.

WE regret to announce the death of Prof. V. Safarik (Schafarik) at the mature age of seventy-three, which took place at Prague on July 2. Prof. Safarik became professor of chemistry in the Bohemian Polytechnicum in 1868. In 1882 he was appointed professor of chemistry in the Bohemian University and in 1892 professor of descriptive astronomy, from which post he retired in 1896. In the fifties and sixties of last century he published several papers in organic chemistry (specific volumes, vanadium, platino-cyanides, &c.), and his last chemical paper was on the constitution of natural silicates, in 1872. Later on he devoted himself to astronomical investigations, which he carried out in his private observatory, and his work on the surfaces of planets, variable stars, &c., is well known to astronomers. He was an adept at grinding and polishing metallic and glass mirrors for reflectors and in silvering the latter. He attended the Bradford meeting of the British Association in 1873, and from that time was often in communication with several leading British astronomers. Those who knew Prof. Safarik personally could not but admire his very wide, almost universal knowledge; indeed, he was one of the last polyhistorians of the Alexander Humboldt school, whose work he translated into the Bohemian language. He has left behind a long series of astronomical observations, which he was prevented by ill-health from publishing.

AT the meeting of the London County Council on Tuesday, the Technical Education Board reported the result of the inquiry by a special subcommittee of the Board as to the need and present provision for special training of an advanced kind in connection with the application of science (especially chemistry and electricity) to industry, and as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries. The report of the special subcommittee deals with matters which the Board points out are of great importance to the present and future prosperity of various English industries, notably some connected with London. The members of the special committee came, without a dissentient voice, to the conclusions (1) that England (and London in particular) has suffered the loss of certain industries and that others are in danger; (2) that this loss has been largely due to defective education, especially in the higher grades; and (3) that London is still seriously behind other cities, notably Berlin, in the provision for the higher grades of scientific training and research. The report was accepted, with the addition of the recommendation "that the Technical Education Board be instructed to report as to the steps it proposes to take in order to give practical effect to the suggestions contained in the report."

GRANTS in aid of the following researches were made at a recent meeting of the Board of Trustees of the Elizabeth Thompson Science Fund:—150 dollars to Prof. H. E. Crampton, Columbia University, New York, for experiments on variation and selection in Lepidoptera. 100 dollars to Dr. F. W. Bancroft, University of California, Berkeley, Cal., for experiments on the inheritance of acquired characters. 125 dollars to Dr. J. Weinzirl, University of New Mexico, Albuquerque, N. Mex., for investigation of the relation of climate to the cure of tuberculosis, it being agreed that if the work justifies it the same amount will be granted next year. 300 dollars to Prof. H. S. Grindley, University of Illinois, Urbana, Ill., for investigation of the proteids of flesh. 300 dollars to Dr. H. H. Field, Zürich, Switzerland, to aid the work of the concilium bibliographicum. 250 dollars to Prof. T. A. Jaggar, Harvard University, Cambridge, Mass., for experiments in dynamical geology, provided the secretary receives the necessary assurance that the work can be undertaken with reasonable promptitude. 50 dollars to Dr. E. O. Jordan, University of Chicago, Chicago, Ill., for the study of the bionomics of Anopheles. 300 dollars to Dr. E. Anding, München, Bavaria, to assist the publication of his work "Ueber die Bewegung der Sonne durch den Weltraum," but the grant is conditional upon other means being also secured by the author sufficient to accomplish the publication. 300 dollars to Prof. W. P. Bradley, Wesleyan University, Middletown, Conn., for investigations on matter in the critical state. 300 dollars to Prof. Hugo Kronecker, Bern, Switzerland, for assistance in preparing his physiological researches for publication. 300 dollars to Prof. W. Valentiner, Grossh, Sternwarte, Heidelberg, Germany, to continue the work of Grant No. 93 (observations on variable stars).

IT is reported that a storm of unusual violence, accompanied by torrential rain and a heavy hail shower, broke over the city of Kieff on July 20. A violent cyclone passed over Chalon-sur-Saône on July 15 between 6 p.m. and 7 p.m., blowing down

chimneys and trees and sinking several vessels on the River Saône.

WE learn from the *Times* that news has been received of a severe earthquake shock at Bandar Abbas on July 9. It commenced at half-past seven in the morning and lasted three or four minutes. All the chief buildings suffered. The Governor's house partly collapsed, while the Customs office was destroyed. The shocks continued in the Persian Gulf on July 9 and 10, and apparently proceeded from Kishm Island. Loud noises at Kishm were distinctly audible at Bandar Abbas. It is feared that the destruction at Kishm is considerable. No further information is available. A few years ago an earthquake at Kishm destroyed hundreds of people. The whole population of Bandar Abbas has flocked to the sea-beach for safety.

A MESSAGE from the Geneva correspondent of the *Daily Chronicle*, dated July 14, says:—A luminous haze has attended the sunsets lately, as if the whole of the west of Switzerland was on fire and the flames reflected in the sky. Swiss men of science attribute this to the presence of fine dust or ashes in the upper currents of air, and are of opinion that this dust has been carried across the Atlantic from Mont Pelée by air currents. This supposition is given support by the news that after a shower of rain at Frauenfeld, in Canton Thurgau, the ground was covered with a thin layer of ashes of greyish-blue colour.

A TELEGRAM from Kingstown, St. Vincent, states that on Thursday last, July 17, several shocks of earthquake were felt there, a terrific shock being experienced at a quarter to ten in the morning, accompanied by a loud rumbling explosive sound like thunder. The worst shock lasted only ten seconds. The shocks were probably caused by explosions of subterranean gas or steam. A few days ago it was reported that the saddle between the two craters of the Soufrière had collapsed, throwing thousands of cubic feet of sand, scoriæ and rock into the funnel of the Soufrière, thus blocking the throat of the crater. In consequence of this, it is suggested that the gas and steam, failing to find any outlet by the throat or funnel of the mountain, caused internal explosions and severe concussions. A *Times* message from St. Thomas states that a severe earthquake was felt in St. Vincent on July 22 at 1.15 in the morning. The shocks were local, and seem to have been confined to a certain area of which Kingstown and its vicinity were apparently the centre.

IT would seem to be the universal belief that volcanic ash has very fertilising qualities, and Prof. d'Albuquerque's contrary view, as a result of the first examination of the St. Vincent ash which fell at Barbados early in May last, was generally regarded with suspicion. The latest number of the West Indian *Agricultural News* contains an interesting paragraph on the subject. Analyses by different authorities in the West Indies and in England showed conclusively, as Prof. Harrison said, "that the volcanic dust was quite valueless as a manure—the value of the soluble constituents being about three cents." Owing to the copious rains that fell in Barbados immediately after the dust, causing a sudden bursting of leaf and flower on plants that had previously been parched by drought, a popular idea was fostered that the dust was, more or less, of a fertilising character. It is believed, probably on good grounds, that it was useful in destroying the small black ants common in the island, and in drying up the egg-clusters of the moth-borer then on the leaves of the sugar-cane.

MR. H. HESKETH BELL, Administrator of Dominica, has a long letter in Tuesday's *Times*, in which he shows that the effects of the recent volcanic eruptions in Martinique and St. Vincent have been greatly exaggerated in many reports. No attempt is made to minimise the disaster, but only to show that the area involved in it is comparatively small. Even estimating the devastated area in Martinique at fifty square miles, there still remain more than 300 square miles in that island that are practically in exactly the same condition as they were in the day before the eruption. With the exception of the blasted triangle on the western slope of Pelée, the whole colony is still dotted with plantations, homesteads and villages. St. Vincent has also suffered, but there are still 43,000 colonists in the island. No other islands have been affected. Although, as has correctly been stated, many of the Leeward and Windward Islands possess craters and volcanic cones, there has so far not been in any of them the slightest sympathetic activity with the outbursts in Martinique and St. Vincent. The fall of volcanic dust that has been noticed in many of the islands has simply been a harmless phenomenon, and, so far as sympathetic volcanic agency may be concerned, it is said that the islands might just as well have been thousands of miles away from the affected craters. Dominica is in precisely the same prosperous condition that it was in the day before the eruptions at Martinique and St. Vincent. Although barely forty miles distant from Pelée and near enough for the inhabitants to hear the detonations, Mr. Bell says the island has been absolutely unaffected by the recent outburst. The hot springs and geysers have remained in their normal condition, and, with the exception of one slight shock of earthquake felt by a few persons, there has not been any seismic disturbance. Even the shower of powdered scoriæ that fell on May 11 was so slight that its presence could only be detected on the surface of palm-leaves and other large foliage.

A CORRESPONDENT sends us from Bath a drawing of a rathe curious development of a foxglove (digitalis). The plant represented was similar to any ordinary foxglove, with the exception that the terminal flower of each inflorescence was not a foxglove blossom, but a Canterbury bell (campanula). This flower, from an external view, looked like any normal Canterbury bell; the stamens, however, were eight in number and similar to those of the foxglove, while the pistil was somewhat like that common to the foxglove. A botanist to whom we submitted the drawing and description tells us he obtained a photograph of the same kind of flower some years ago, and upon inquiry he found that the anomaly is fairly frequent and well known. The combination of two flowers other than the foxglove and campanula, if it occurs, would, however, be worth recording. The specimen from which the photograph mentioned was taken grew in a semi-wild garden in Surrey not far from London.

THE use of oxygen inhalers in connection with high balloon ascents was mentioned last week (p. 279). On the occasion of the last Aëronautical Congress held at Berlin, a report on the inhalation of oxygen was presented, and the subject has also occupied the attention of the Société française de Navigation aérienne. The July number of the *Aëronautical Journal* contains a report of a lecture delivered by Dr. Süring before this Society upon his ascent with Dr. Berson on July 31, 1901, when the height of 10,800 metres was reached. It was pointed out that as to the physiological side of the question, on closely studying foreign and German ascents, three stages may be distinguished. During the first of these stages the excitement exceeds considerably the phenomena of height-sickness proper, resulting from want of oxygen. In such a state of excitement, one does not know, perhaps, the real state of the height-sickness, and this naturally becomes an exceedingly critical matter when the dangers of a mishap become imminent. The regrettable issue of the *Zenith* expedition in the year 1874 is no doubt to be traced to this, to a large extent at any rate. The second and more dangerous stage is that of confusion. By systematically inhaling oxygen, this state of excitement leading to confusion and imminently dangerous conduct can be warded off by

aëronauts of ordinarily cool disposition; whereas it is evident that a state of enervation with signs of relaxation cannot be completely prevented. Notes are illegibly written in the wrong place, the eyes refuse their services, the slightest exertion results in a dangerous weakness, and, fiually, the whole organism falls a victim to an inevitable need for sleep. But, also these illnesses may yet be overcome to a certain extent if greater precautions are taken in future ascents, if the aëronaut avoids all exertions, all excitement, sleeps sufficiently, undergoes a still more systematic inhaling of oxygen, begins earlier with it and protects himself sufficiently against cold.

PERHAPS the most singular statement in the Meteorological Office pilot chart for the month of August is that relating to the appearance, early in July, of a fairly large ice floe, 40 feet by 15 feet and a foot out of water, off the west of Scotland, close inshore on the Treshnish Islands, on the west side of Mull, and only a few miles from Tobermory. From other sources it appears that the fishermen who saw it could not be mistaken, as they sailed within 20 feet of the floe. It was reported by independent observers on two days. There can be little doubt that it was the remains of one of the icebergs which had for some time been infesting the coast of Iceland, but it would be interesting to trace its movements southward. Off Mull it was travelling in a north-easterly direction, so it is reasonable to suppose that it had at first drifted southward outside the Hebrides before the northerly winds which prevailed so long earlier in the season. While we have had this quite exceptional circumstance on our side of the Atlantic, the ice record about the Newfoundland banks remains almost blank. Three or four observers report a berg in about 48° N., 49° W., and there was one in 42° 40′ N., 47° 30′ W. The strait of Belle Isle had been clear of ice until about the end of June, but early in July several bergs had drifted in past Belle Isle. There was, however, nothing like the usual quantity at this time of the year, and shipmasters appear to have seen nothing of the heavy ice of a month earlier, which was reported to block the approaches to the strait. This freedom from ice probably explains the excess in the temperature of the sea surface on the banks and over an extensive region eastward and westward during the month of May last, the results of which, derived from 4400 observations, are shown on an inset chart.

AN interesting review of recent work in wireless telegraphy is commenced in *L'Eclairage Électrique* for July 5. The article is by M. Turpain, himself a worker in this field. It is noteworthy that the author is unable to credit Mr. Marconi's having succeeded in signalling across the Atlantic, and attributes the signals received at Newfoundland to atmospheric effects. No reference to the later experiments on the *Philadelphia* is made. M. Turpain also quotes evidence to show that the successful solution of the syntony problem has not as yet been found by Mr. Marconi. Prof. Slaby's system and the experiments with a repeater made by M. Guarini are also described in this instalment.

THE *Journal de Physique* for June contains an article by M. Armagnat on the study of resonance by means of oscillographs. The paper deals with the subject both theoretically and experimentally. The method has been devised because the wave forms obtained by means of an oscillograph, or other wave-tracing instrument, are not accurate enough to allow of the harmonics being found by means of graphical analysis. Two oscillographs are used, one in series with a non-inductive resistance tracing the wave-form under examination; the other is in series with a variable self-induction and capacity which are altered until the different harmonics are resonated and traced on the screen. The paper is illustrated by some interesting curves obtained in this manner, one of which shows how the method may be used to measure the irregularities in the speed of an alternator.

IN the "Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam (Tweede Sectie)," Deel ix. pp. 1–12, Dr. P. H. Eykman has published an interesting paper describing a method for obtaining a Röntgen photograph of an internal part of the living body during the performance of a definite functional movement. The author applies the method to the investigation of the motion of the tongue, pharynx and larynx in swallowing. He fixes a contact on the Adam's apple, the motion of which closes the current which feeds the Röntgen tube at a perfectly definite moment during the motion. The motion has to be repeated 120 or 130 times with the contact in exactly the same position in order to obtain a distinct photograph. Other photographs of different phases of the motion are obtained by altering the position of the contact. The photographs are good considering the difficulties of the experiment and throw a welcome light on the position of the epiglottis and on the condition of the upper opening of the larynx during the act of deglutition.

ALCOHOL as a motive power has formed an interesting set of experiments in France at the present time, the object being to produce a home-made substitute for petrol, which all has to be imported. According to *Feilden's Magazine* for July the results obtained are of a satisfactory nature. both for the heavier and lighter types of cars, and it is stated that passenger cars driven by alcoholic traction have been proved to hold their own against those with petrol as a motive power. The price of alcohol at present is higher, but by the use of beet-root in its manufacture its market value has been greatly reduced. The experiments showed that the amount of alcohol consumed by the engines (which were designed to burn petrol) was 50 per cent. higher than that of petrol, but it is stated that with engines properly constructed to use the new motive power this difference would be greatly reduced, and should this be the case it will form a home-made motor-car spirit to replace the imported article. Attention is also directed to the ease with which it can be prepared from potatoes, and consequently, on account of its general utility for heating, lighting, &c., it would seem that an opportunity is open for Ireland to create a most important industry.

MR. M. L. SYKES has favoured us with a copy of his paper on the evolution of butterfly-scales, published in the *Report and Transactions* of the Manchester Microscopical Society for 1901. The illustrations show that the scales of butterflies which mimic other species are generally quite different in form from those of the species mimicked.

ACCORDING to a photograph, taken from a living example, of which a reproduction is given by Dr. Jentink in *Notes* from the Leyden Museum for July, the form given to the nose in mounted specimens and figures of the proboscis-monkey of Borneo is quite incorrect. Instead of being sharply pointed, compressed, and projecting straight forwards, this appendage is expanded and depressed at the extremity, which hangs down in front of the upper jaw so as to conceal the greater part of the mouth in a full-face view.

MARINE fish-destroyers form the subject of an article by Prof. W. C. McIntosh in the May number of *Harper's Magazine*, in the course of which the chief types of extinct and living marine monsters destructive to sea-fish are described and illustrated. The author considers that such destroyers have done much more harm than man to food-fishes, and suggests that little good is done by regulations for controlling sea-fisheries.

Whether he is justified in classing the freshwater labyrinthodonts as marine fish-destroyers may be open to question; and his statement that the American Devonian fish Dinicthys occurs in the English "Old Red" does not appear to rest on good foundation. Why he should say that plesiosaurs "*continued* to the Mesozoic" is hard to understand; and his estimate of the size of the dinosaurian Atlantosaurus (100 feet long and 30 feet high) appears a gross exaggeration.

To the *Notes* from the Leyden Museum Dr. R. Horst contributes some remarks on the habits of the cocoanut-crab, based upon observations made on captive specimens at Batavia and living examples near Bantam by Mr. C. P. Sluiter. Recently some doubts have been expressed as to whether it is in the habit of ascending palm-trees. Mr. Sluiter has, however, seen these crabs climb to the top of mangrove-trees and palms fully 60 feet in height. What they did when at the top he was unable to ascertain, but, from observations made on captive specimens, he considers it probable that they were engaged in opening young cocoa-nuts and devouring their contents. Whether they have the power of opening ripe cocoanuts could not be determined, the specimens under observation merely fumbling such as were given them without attempting to penetrate the shell.

AT the conclusion of a memoir on the structure of the retina of the eye, published in the *Quarterly Journal of Microscopical Science* for July, Mr. H. M. Bernard states that this structure can no longer be regarded as being built up of a number of distinct cells, each of which possesses distinct and definite functions. On the contrary, if distinct cells ever exist, their walls must be broken down at a very early stage of development. In technical terms, the retina is a continuous cytoplasmic reticulum containing non-stationary embedded nuclei. The other papers in the same serial include one by Mr. H. J. Fleure on the relations of the kidneys in Haliotis, and a second, by Miss I. Drummond, on the development of Paludina.

IN most seismographs, the records are made on a sheet of glass or strip of paper which is either set in motion by an earthquake or has an ordinarily slow velocity increased at a somewhat advanced phase of the shock. In either case the interesting preliminary tremors are more or less completely lost. During the last three years, however, Dr. Cancani has avoided this loss by keeping the strip of paper continuously moving at the rate of six metres an hour. This velocity he has shown to be sufficient to decipher vibrations with a period of one-twentieth of a second and therefore above the lower limit of audibility. In a paper recently published (*Boll. Soc. Sismol. Ital.*, vol. vii. pp. 292–298), he maintains that even this velocity may be conveniently increased to one ten times as great and therefore capable, so far as speed is concerned, of registering the vibrations of earthquake-sounds occurring at the rate of 200 per second.

A WORTHY notice of the life and scientific work of the late Prof. P. G. Tait is contributed to the *Physical Review* (July) by Mr. A. Macfarlane, and is accompanied by a portrait of Tait printed in photogravure on plate paper.

MESSRS. CROSBY LOCKWOOD AND SON have ready for publication a volume entitled "Aërial Navigation," by Mr. Frederick Walker, dealing with the construction of dirigible balloons and other flying-machines; and another on the "Elements of Agricultural Geology," by Mr. P. McConnell.

IN the abstract of the paper on refractive indices by Mr. J. W. Gifford, published in NATURE of July 17 (p. 287), line 12 reads, "The difference of the angles of the prisms from 60° were in each case *less than* 4 *seconds of arc*." Mr. Gifford informs us he should have said, "*less than* 4 *minutes of arc*."

AN interesting essay on "Clouds and Weather Signs," by Commander D. Wilson-Barker, has been reprinted from *Knowledge* and issued as an illustrated brochure. The pictures of clouds which the publication contains are exceptionally fine, and the descriptions of them should be the means of increasing the number of scientific observers of cloud phenomena.

IN the article on "Some New Forms of Geodetical Instruments" which appeared in last week's NATURE, it should have been mentioned that the illustrations of the instruments were from Sir Howard Grubb's paper in the *Transactions* of the Royal Dublin Society (vol. vii. No. 15). We are indebted to the Society for the use of the illustrations.

THE firm of Gustav Fischer, Jena, has begun the publication, in parts, of a new edition of the attractive work on deep-sea exploration entitled "Aus den Tiefen des Weltmeeres," by Prof. C. Chun. Although the original volume was remarkable for the large number of interesting and beautiful pictures, the second edition will contain many new illustrations. The work is one of five which are used as the text for an interesting essay on the methods and results of deep-sea investigations, in the current number of the *Quarterly Review*.

AN excellent series of lecture experiments illustrating different types of catalytic reactions is described by Messrs. Noyes and Sammet in vol. xli. of the *Zeitschrift für physikalische Chemie* (pp. 11–27). For convenience, catalysators are divided into seven classes, namely, carriers, absorbent contact-substances, electrolytic contact-substances, water, dissolved electrolytes, enzymes and inorganic colloid substances, and by means of the simple experiments described, the catalytic function of substances belonging to any one of these classes in increasing the velocity of chemical change can be demonstrated to an audience in a very satisfactory manner.

AN investigation of the rate of hydrolysis of sulphonic acid esters, published by R. Wegscheider in vol. xli. of the *Zeitschrift für physikalische Chemie*, has shown that this phenomenon is very different in character from that observed with the ordinary carboxylic esters. Whilst the latter are hydrolysed much more rapidly by solutions of acids than by pure water, the hydrogen ion of the acids being supposed to act as a catalytic agent, the hydrolysis of sulphonic acid esters is scarcely accelerated at all by acids. A further study of this subject would no doubt afford valuable information with regard to the essential difference between these two classes of acids.

TO the numerous syntheses effected by means of the magnesium alkyl halogen compounds is to be added an extremely elegant method of passing up the series of carboxylic acids. Messrs. Houben and Kesselkaul, in the current number of the *Berichte*, describe the synthesis of carboxylic acids by means of the action of carbon dioxide upon these magnesium compounds. Thus, as an example, ethyl bromide is treated with magnesium in the usual way and a slow stream of carbon dioxide passed in; propionic acid is easily isolated from the product in a yield corresponding to 50 per cent. of the theoretical. Acetic, propionic, benzoic and phenylacetic acids have been synthesised in this way, so that the generality of the method is well established.

AT the Municipal Observatory of Montsouris the quantitative examination of atmospheric air has been carried out for a period of twenty-five years. About six years ago some special researches were commenced, under the direction of M. Albert Lévy, by MM. Henriet and Pécoul, the first results of which were presented to the Academy of Sciences in 1898. The fact was announced that atmospheric air which had been perfectly freed from carbon dioxide by an exhaustive treatment with potash and

baryta, on circulating repeatedly by means of a mercury circulator through a fresh quantity of baryta, gave appreciable amounts of barium carbonate corresponding to the production of amounts of carbon dioxide of an order nearly approaching, in some cases, the amount of carbon dioxide originally in the air. These facts were so extraordinary that the Academy appointed a commission, consisting of MM. Armand Gautier, Haller and Ad. Carnot, to repeat and report on this work. Their report is published in the current number of the *Comptes rendus*, and they confirm in every particular the views originally stated by MM. Henriet and Pécoul. M. Henriet also publishes in the same number an account of an attempt made to determine the nature of the gaseous substance present in the air capable of giving these results, and comes to the conclusion that there is present in the air of Paris the vapour of a substituted formamide, the slow hydrolysis of which by the baryta furnishes the carbon dioxide originally found.

THE additions to the Zoological Society's Gardens during the past week include a Black Lemur (*Lemur macaco*) from Madagascar, presented by Mr. Thomas Watson ; a Hybrid Zebra (between *Equus burchelli* and *E. caballus*) from South Africa, presented by H.M. The King ; a Caracal (*Felis caracal*) from South Africa, presented by Regimental Quatermaster-Sergeant Glenton, L.R. ; two Javan Peafowls (*Pavo spicifer*) from Burmah, presented by Mr. O. F. Wheeler Cuffe ; a —— Ouzel (*Merula*, sp. inc.) from India, presented by Miss Porter ; thirteen Slow-worms (*Anguis fragilis*) British, presented by Mr. C. J. Frielander ; a Mongoz Lemur (*Lemur mongoz*) from Madagascar, seven Cunningham's Skinks (*Egernia cunninghami*) from Australia, four Amphiumas (*Amphiuma means*), a Corn Snake (*Coluber guttatus*) from North America, two Ruddy Sheldrakes (*Tadorna casarca*) European, deposited ; a Wapiti Deer (*Cervus canadensis*, ♂) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

BRIGHT METEOR OF JULY 13.—Several letters referring to observations of the bright meteor of July 13 have been received, in addition to those mentioned last week (p. 281).

Mr. O. J. R. Howarth observed the meteor at Chelsea, his attention being attracted by a flash resembling a very powerful searchlight, of a bluish hue, which lit up the sky and street brightly for an instant. "On turning to discover the cause a trail of light of considerable breadth (perhaps 1°) was observed. It was of serpentine form, about 10° in length, of a granulated appearance, and gradually faded from a bright golden colour, remaining visible from eight to ten seconds. Its elevation was estimated at 60°, and its direction was about S.E. from Chelsea."

Mr. W. Gilles, observing at Deal, says :—"The meteor became visible about 10° S. of the zenith and left a luminous trail of a remarkably sinuous character at its commencement, which was visible for about one minute afterwards."

RADIAL VELOCITY OF THE ORION NEBULA.—In No. 5, vol. xv. of the *Astrophysical Journal*, Prof. H. C. Vogel gives an interesting description of the methods employed, and the results obtained, by Dr. Eberhard and himself in determining the radial velocity of the Orion nebula.

The spectrograms were obtained by Dr. Eberhard with a photographic refractor of the Potsdam Observatory, which has an aperture of 32·5 cm. and a focal length of 343 cm. Owing to the lens not being fully corrected it was impossible to photograph lines of greater wave-length than Hγ. An exposure of 180 minutes, using a three-prism spectrograph, gave a spectrum in which, at Hγ, 0·25 mm. corresponds to a difference of 0·424 $\mu\mu$, whilst an electrical heating apparatus enables the observer to maintain a constant temperature in the prism box within a tenth of a degree for several hours.

Seven spectrograms, taken between November 22, 1901, and February 22, 1902, each showing two iron comparison spectra in addition to the nebula spectrum, gave very uniform results, the mean of which, as measured by both observers, indicates a velocity of recession, relative to the sun, of 17·4±1 km., and this agrees very well with the 17·7±1·28 km. obtained by Keeler as the velocity of this object in his classical researches on the velocities of nebulæ.

Several drawings of the Hγ line which are given plainly indicate the existence of differential velocities in various parts of the nebula.

MOTION OF THE POLE.—In No. 523 of the *Astronomical Journal*, Dr. J. C. Chandler directs attention to the apparent existence of a fifteen months' periodical motion of the pole, which has not yet been identified. This apparent motion is so minute (0″·05) that Dr. Chandler hesitates to assert its real existence, but at the same time he cannot account for the constant differences in the coordinates by any other supposition, and he summarises his article with the following statement :—"In dealing with a phenomenon so obviously complex as these motions of the earth's axis are, and until we are certain of the superior limit of precision in astronomical measurement, it would be unphilosophical to ignore without examination such indications as these."

PHOTOGRAPHS OF THE PERSEIDS IN 1901.—M. J. Sykora communicates to the current number of the *Memorie della Societa degli Spettroscopisti Italiani* the results obtained by the staff of the Jouriew Observatory (Dorpat) in photographing the Perseid trails in August, 1901.

Seven meteor trails were found on the negatives obtained, but of these two were evidently not due to Perseids. Of the remaining five, two were remarkable, inasmuch as they show the explosion of meteors, one in the middle of its trail, the other at the end of its trail ; drawings of these accompany the article.

Measurements of the trails in regard to the coordinates obtained from stellar images on the same negatives give the radiant point for August 11 as

$$\alpha = 43^\circ\ 55'{\cdot}8 \quad \delta = 57^\circ\ 10'{\cdot}3,$$

whilst the radiant point for August 12 is evidently slightly east of this position.

VARIABLE STARS.—2815 *U Geminorum*.—Mr. J. A. Parkhurst has observed the latest maximum of 2815 U Geminorum with the 12-inch and 40-inch refractors of the Yerkes Observatory, and finds a range of 3·04 magnitudes between April 3 and May 8, the maximum (9·76 m.) being attained at 13·9 h. on April 14.

Mr. Paul A. Yendell, of Dorchester, U.S.A., has made observations of the four following variable stars :—

2279 *T Monocerotis*.—Eleven observations of this star in 1900, and forty-six from December 1, 1901, to April 24, 1902, show four minima and five maxima.

2335 *W Geminorum*.—Fifty-one observations extending from November 24, 1901, to April 28, 1902, indicate five maxima and one minimum.

2509 ζ *Geminorum*.—Four maxima and three minima are deduced from thirty-two observations of this star made between December 27, 1901, and May 2, 1902.

2676 *U Monocerotis*.—Twenty observations from January 13 to April 14, 1902, include a minimum of 7·1 m. on January 30 and a maximum of 6·2 m. on February 12. (*Astronomical Journal*, No. 523).

THE AUGUST METEORIC SHOWER.

LIKE the great majority of meteoric streams, the Perseids return every year, and if they do not compose a really brilliant display they form a very noteworthy shower. An observer attentively watching the firmament on about August 11 may sometimes count 100 meteors in an hour, but the moon must be absent and the atmosphere very clear. In those years when it is most conspicuously exhibited it well repays observation even by those persons who do not specially apply themselves to this department of astronomy. At the close of July and opening of August there are comparatively few Perseids visible, but there is a rich shower of Aquarids at that particular epoch, so that meteors are generally pretty numerous, and occasionally surprisingly so.

Watching for these objects on ordinary nights is sometimes apt to prove tedious even to enthusiasts, but the Perseids are always sufficiently frequent and brilliant on about August 10, 11 and 12 to attract the interested attention of the most casual

stargazers. There are few more alluring spectacles than that afforded by the prolific fall of meteors on a genial August night, and we need not wonder that in the past few years observers of these phenomena have greatly increased, and that a more general interest than formerly is taken in recording apparitions of shooting stars.

This year the conditions will be favourable, for the moon will not offer any serious impediment to observation between about July 28 and August 12. It will be possible, therefore, to watch the progress of the shower through the fortnight comprising its more active stages. The weather is often a great drawback to investigations of this character (and this particularly applies to the English climate), for cloudy skies destroy the continuity of the work and occasion breaks which materially affect the value of the results. In watching a display similar to that of the Perseid stream, which is presented over a comparatively lengthy period, it is most essential to secure observations on many successive nights, so that the relative strength of the shower and the position of its radiant point may be determined at short and regular intervals. This is, however, not often practicable in England, though in exceptional cases there is little to take exception to in regard to prevalent weather. For instance, in August, 1901, thirteen of the fifteen nights from the 10th to 24th inclusive were clear, or partly so, and enabled observations to be obtained.

Everyone who views a meteoric shower would do well to record some of its leading features. One of the most important requirements is that the apparent paths of the meteors amongst the stars be registered. The fainter class of objects may be disregarded, but the lines of flight of the brighter meteors should be marked upon a celestial globe or star chart, and the right ascension and declination of the beginning and end points read off and entered into a book suitably ruled for the purpose. Such records, if carefully and accurately acquired, possess considerable value, as they furnish the materials from which the real paths and radiants of the individual meteors may be ascertained. Even those observers who have had no previous experience in work of this kind should make an effort to record the Perseid shower, for it will furnish an entertaining and instructive employment, and probably intensify their interest in the subject. In spite of the oft-repeated observation of the August display in past years, we have by no means completed our knowledge of its visible behaviour, and it should be further watched for data to enable us to more fully comprehend its various observational and theoretical aspects. W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced from Berlin that the Academy of Münster has been raised to the *status* of a University.

AT University College, London, on July 14, Mr. H. E. H. Smedley gave a demonstration of his methods of wax-modelling as applied to plant structures, more particularly with a view to elucidating complex anatomical relations.

AT Bedford College for Women (University of London), Dr. W. H. Willcox has been appointed lecturer in hygiene. The Pfeiffer scholarship in science has been awarded to Miss E. A. Bridger. Six open Pfeiffer scholarships of the value of 15 guineas will be awarded to the best candidates holding a degree, or equivalent, in arts or science wishing to train as secondary teachers. Application should be made to Miss H. Robertson, the head of the training department, not later than December 13, 1902.

AMONG the examiners for the London Matriculation Examinations of September, 1902, and June, 1903, we notice the following:—Mathematics, Mr. W. D. Eggar and Prof. G. B. Mathews, F.R.S.; physics, Dr. A. H. Fison and Mr. D. Rintoul, M.A.; chemistry, Mr. H. B. Baker, F.R.S., and Dr. G. S. Turpin; botany, Mr. H. Richardson and Mr. V. H. Blackman; zoology, Dr. G. Herbert Fowler and Mr. O. Latter; geography, Mr. G. G. Chisholm and Prof. W. W. Watts; geometrical and mechanical drawing, Mr. Walter Hewson and Mr. H. G. Christ.

IT will be remembered that in January last the Drapers' Company offered to devote the sum of 30,000*l.* to the extinction of the debt on University College, "provided that the Senate of the University of London and the Corporation of University College can, before February 28, 1903, agree upon a scheme for the incorporation of the college in the University, and such scheme be approved by the Company." The *University Gazette* of July 19 announces that the Senate has considered the proposal in all its bearings, both administrative and financial, and has approved the outlines of a scheme which had been drafted in conference with the council of the college as a preliminary step towards its realisation. Further negotiations are in progress between the University and the college with respect to certain details, and it is hoped that by the date specified a complete scheme for the incorporation of the college in the University may be agreed upon by both parties. The realisation of the scheme will depend upon whether it is possible to raise the necessary funds.

THE Directory of the Board of Education, South Kensington, has been superseded by "Supplementary Regulations for Secondary Day Schools and for Evening Schools," a copy of which has just been received. The greater part of the volume (pp. 42 to 241) consists of syllabuses of the subjects in which the Board of Education holds examinations. There are, in addition, syllabuses of certain subjects in which the Board does not hold examinations and lists of apparatus suitable for use in science classes. Some of the syllabuses contain very helpful instructions for experiments and other practical work. For instance, the syllabus of practical plane and solid geometry gives outlines and hints for a course of construction and measurement of an original character, much in advance of the traditional plane and solid geometry and geometrical drawing. The syllabuses which were formerly given in the Code for Evening Continuation Schools are now included in the volume before us, among the subjects being general rudimentary science and elementary rural science.

SCIENTIFIC SERIALS.

THE *Journal of Botany* for July opens with an account by Mr. G. S. West of algæ obtained from hot springs. One collection from Iceland consisted mainly of filamentous Myxophyceæ and small Diatoms. A new species of the genus Aulosira was found in considerable abundance, also *Mastigocladus laminosus*, which is commonly found in all hot springs. Twelve genera of green and blue-green algæ are represented. A second collection from Sira Ramau in the Malay Peninsula produced two new species, a Symploca and a Phormidium. Figures of the more important species are given on an accompanying plate.—Mr. Spencer le Moore describes five new species of Rubiaceæ, and three belonging to the Asclepiadaceæ, occurring in Dr. Rand's Rhodesian collections which are incorporated in the National Herbarium.—In the list of Glamorganshire plants observed by the Rev. E. S. Marshall and W. A. Shoolbred in June last year, several new records are given.—The varieties of *Hieracium anglicum* form the subject of a note by Mr. F. A Williams.—Mr. E. F. Linton contributes an appreciative biography of the late Mr. J. C. Mansel-Pleydell.

American Journal of Science, July.—On spectra arising from the dissociation of water vapour, and the presence of dark lines in these spectra, by John Trowbridge. With powerful discharges in hydrogen, oxygen and rarefied air the same spectrum is obtained, and this is regarded as arising from the dissociation of rarefied water vapour. From a study of the spectrum of powerful spark discharges under water the author concludes that dissociation of water vapour takes place in the atmosphere of the sun; oxygen must therefore be present. The dissociation of water vapour, under the effect of powerful electrical discharges in the presence of small amounts of atmospheric air, results in the production of argon, even in tubes presumably filled with dry hydrogen. The great brilliancy of the dissociation spectrum of water vapour, which obscures the spectra of metallic vapours, and the presence of dark lines due to photochemical reversals, show the need of caution in accepting photographic evidence in regard to the states of development of stars.—The occurrence of Greenockite on calcite from Joplin, Missouri, by H. B. Cornwall. The Greenockite occurs as a bright yellow, dust-like coating on the calcite, which can be easily rubbed off with the finger. Beneath this coating is a thin layer of sphalerite.—A quantitative study of variation in the fossil brachiopod *Platystrophia lynx*, by E. R. Cumings and A. V. Mauck.—Studies of Eocene Mammalia in the Marsh

collection, Peabody Museum, by J. L. Wortman. The present instalment contains details of *Sinopa minor*, *Sinopa major*, together with observations upon the marsupial or metatherian relationships of the Creodonts. A summary of the results obtained for the whole series of Eocene Carnivora in the Marsh collection is appended.—New exposures of eruptive dikes in Syracuse, by P. L. Schneider.—Petrography of recently discovered dikes in Syracuse, N.Y., with note on the presence of melelite in the Green Street dike, by C. H. Smyth, jun.—The significance of certain Cretaceous outliers in the Klamath region, California, by O. H. Hershey.—The action of copper sulphate upon iron meteorites, by O. C. Farrington.—The classification of meteorites as active and passive towards solutions of copper sulphate, as given by Wöhler, is shown to be untenable. The rapidity with which the copper is deposited upon a thoroughly cleaned surface appears to decrease with the increase of the percentage of nickel, the temperature remaining constant, and hence meteoric iron, which always contains nickel, may be readily distinguished from terrestrial iron by this reagent.—A petrographical contribution to the geology of the eastern townships of the province of Quebec, by J. A. Dresser.—The action of carbon dioxide upon the borates of barium, by L. C. Jones. A criticism of the method for estimating boric acid of Morse and Burton.—Studies in the Cyperaceæ, by T. Holm.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 19.—"On the Correlation between the Barometric Height at Stations on the Eastern Side of the Atlantic." By Miss F. E. Cave-Brown-Cave, Research Student of Girton College, Cambridge, with some assistance from Karl Pearson, F.R.S., University College, London.

In a memoir on the correlation and variation of the barometric height at divers stations in the British Isles by Prof. Karl Pearson and Dr. Alice Lee, it is suggested (i.) that interesting results might be obtained by correlating the barometer at stations on the east and west sides of the Atlantic, allowing an interval of time between the observations (see *Phil. Trans.* vol. cxc. A. p. 459); and (ii.) that with a certain distance between stations, the correlation would be found to be negative, *i.e.* a high barometer at the one station corresponding to a low barometer at the second (see p. 467).

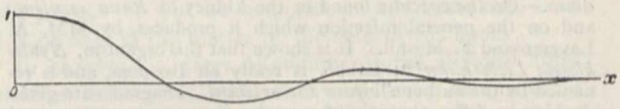
In order to deal with these points, steps were taken in 1897 to collect the necessary material. Twenty years, 1879–1898 inclusive, were selected for consideration, and the early morning barometric observations for these years, copied from material provided by the kindness of the British and other Meteorological Offices.

A preliminary study has been made of the East Atlantic stations, and this has impressed us with the desirability of continuing, if possible, our chain of stations right down the west coast of Africa, even to the Cape. The great mass of material to be dealt with, and the many new problems which arise in an almost entirely novel investigation of this kind, have meant, of course, very slow progress, and while publication of the final conclusions must be delayed for some time yet, it seems desirable to draw attention to a few of the results already reached for the East Atlantic stations.

In the first place it was soon discovered that the winter and summer months (equinox to equinox) must be treated separately. It was already known that the average height varied considerably in the summer and winter months, but there are also very significant differences in the variability, and, in what we are most concerned with, the *correlation*. For example, there is hardly any correlation (0·04) between Lisbon and Valencia in the summer, but in the winter it is quite considerable (0·22). Further, the results worked out in two groups of ten years each, show that very sensible differences in mean, variation, and correlation can exist between one decade and the next, so that at least twenty and probably more years are desirable if we are to obtain steady values for the barometric constants. In the next place, while we have found a small but sensible cross Atlantic barometric correlation after a definite interval of time, we must wait for more complete American data, and for still closer investigation of the best interval for different stations before results on this point are published. The second suggestion, however, has been amply verified, and to draw attention to this is the principal object of the present preliminary notice.

As we go generally south from any station, we reach a point at which for readings on the same day there is no correlation at all. *For stations beyond this point the correlation becomes negative, reaches a negative maximum, and then begins to decrease.* Clearly it must reach a second zero. What happens after this? Does the correlation remain zero for all greater distances? To fully answer this problem we must obtain data south of Sierra Leone—in fact, we want data for St. Helena, Ascension, and the Cape, and have taken steps to obtain them.

Thus Valencia is positively correlated with Bødø. Lisbon, however, is negatively correlated with Bødø, but positively with Valencia. We require to go as far south as Funchal to find a negative correlation with Valencia. To get a negative correlation with Lisbon we must go as far as Sierra Leone, which has become positive again for both Bødø and Valencia. At St. Helena we have our second negative correlation zone for both Bødø and Valencia, while we are only in the second positive zone for Lisbon. In other words, the curve of barometric correlation with distance from a station appears to give roughly the form:—



We do not find with increasing distance a diminishing correlation, as of a curve rapidly asymptoting to $o\,x$, but as it were a wave-curve of diminishing amplitude. There is not apparently an area of positive correlation surrounded by a field of zero correlation, but going south there are only *points* of zero correlation, not *regions* of zero correlation. Probably if the area of investigation can be extended we shall find *lines* not zones of zero correlation round each station, separating districts of positive and negative correlation. What we are certain about is, that a zone of positive correlation is followed by a zone of negative correlation. What we are less sure about is, that this negative zone is again followed by a positive zone of much less intensity, but our rather meagre results certainly suggest it.

Full numerical data are given in the paper for Bødø, Skudesnes, Valencia, Lisbon and Funchal, and less complete data for Sierra Leone and St. Helena.

We hope shortly to complete our calculations to the Cape, and then to finish the work already begun on the American stations. Meanwhile, we think that the correlation of a series of stations following roughly a parallel of latitude across Europe and Russian Asia would throw a flood of light on whether a chain of roughly north and south stations differs wholly in character from a chain of east and west stations. The magnitude of the computations, however, almost precludes the idea that any individual worker or workers can hope to complete such a task within a reasonable period.

DUBLIN.

Royal Dublin Society, June 18.—The Right Rev. Monsignor Molloy in the chair.—Prof. J. Joly, F.R.S., communicated a paper by Mr. W. B. Wright, of the Geological Survey, on some results of glacial drainage round Montpelier Hill, co. Dublin. At the lowest point of the ridge which connects the outstanding hill of Montpelier with the main mass of the Dublin Mountains to the south is a dry, transverse gap, connecting the valleys on either side; this gap cuts directly across the junction of the granite and slate, and has apparently no reference to the structure of the rock in which it is excavated. The occurrence in one of the side valleys of a thick deposit of gravels, ending in a fairly straight line on the Boulder Clay plain, which stretches up to its mouth, is suggestive of the occurrence in this valley, during the later stages of the decay of the ice sheet, of an ice-dammed lake which had its overflow channel through the gap. The gravel is composed for the most part of limestone and other material foreign to the ice sheet, indicating that the depositing waters flowed mainly from the ice sheet. At the other end of the gap are some mounds of granite and slaty material, probably the débris from it. At a subsequent period the drainage appears

to have been directed round the north side of Montpelier Hill, and has left its traces here in a series of terraces and incipient channels.—Dr. E. J. McWeeney made some remarks on a bacteriological method of air examination.—Mr. H. J. Seymour, of the Geological Survey, gave a short note on the occurrence of cassiterite in the Tertiary granite of the Mourne Mountains, co. Down.—Monsignor Molloy described and demonstrated working models of a three-phase generator and a three-phase motor, suitable for lecture purposes.

PARIS.

Academy of Sciences, July 15.—M. Bouquet de la Grye in the chair.—On the structure and history of the lunar crust: observations suggested by the fifth and sixth numbers of the "Photographic Atlas of the Moon," published by the University of Paris, by MM. Lœwy and P. Puiseux.—Preparation and properties of a silicide of vanadium, by MM. H. Moissan and Holt. A mixture of vanadium oxide, V_2O_3, with about five times its weight of pure silicon is heated in the electric furnace for four or five minutes. The compound VSi_2 is formed; it can also be prepared by the action of magnesium powder upon a mixture of silicon and vanadic acid. Heated in a current of hydrochloric acid gives silicochloroform and a mixture of chlorides of vanadium.—On the coccidia found in the kidney of *Rana esculenta* and on the general infection which it produces, by MM. A. Laveran and F. Mesnil. It is shown that this organism, *Hyaloklossia Lieberkühni* of Labbé, is really an Isospora, and is renamed by the author *Isospora Lieberkühni*. Diagrams are given showing its different stages of growth; it causes an acute mixed nephritis in the frog.—The direct hydrogenation of acetylenic hydrocarbons by the method of contact, by MM. Paul Sabatier and J. B. Senderens. The method of direct hydrogenation by contact with nickel or copper has been applied to œnanthylidene and phenyl-acetylene. With nickel the chief product in the first case is normal heptane; with copper a heptene together with a small amount of heptane. With phenyl-acetylene nickel gives chiefly ethylcyclohexane; with copper ethylbenzene, with small quantities of diphenyl-butane and metastyrolene.—Report on the experiments made at the Observatory of Montsouris relating to the composition of atmospheric air, by MM. Armand Gautier, Haller and Ad. Carnot. The experiments of MM. Lévy, Henriet and Pécoul on the existence of an easily oxidisable gaseous compound in the air of Paris have been repeated and confirmed (see p. 308).—The use of hail rockets, by M. E. Vidal. Evidences are given of the power possessed by the rockets of breaking up storm clouds, and especially of preventing damage to vines by hail.—Application of the method of the arithmetical mean to the surfaces of Riemann, by M. A. Korn.—On the formation of liquid drops and the law of Tate, by MM. Leduc and Sacerdote. The law of Tate states that the weight of the drops of a given liquid falling from the extremity of a tube is proportional to the radius of the end of this tube. It is shown that this is only approximately true and that the usual reasoning establishing this law is inexact. A new expression is deduced which is submitted to an experimental study.—On binary accords, by M. A. Guillemin.—On a new organic vapour in atmospheric air, by M. H. Henriet. Filtered air is mixed with steam and this is then condensed. The condensed water was then examined and found to contain a minute amount of what would appear to be a substituted formamide.—On the properties and constitution of the peroxides of zinc, by M. de Forcrand.—On oxyisopropylphosphinic acid, by M. C. Marie.—On a new method of preparation of α-substituted β-ketonic esters, by M. René Locquin.—The electric resistivities of pathological blood serums and serous effusions in man, by MM. Lesage and Dongier.—The zymase from *Eurotiopsis Gayoni*, by M. Mazé. It has been found that the zymase is present in considerable quantity in the developing mycelium, but that with aërobic cultures the quantity of the zymase present in unit weight of mycelium diminishes rapidly with the age of the cultures.—On the cure of "la casse" in wines by the addition of sulphurous acid, by M. J. Laborde. The author criticises the views of MM. Bouffard and Dienert, and gives fresh experimental evidence in favour of the hypothesis originally advanced by him.—Researches on the Culicides of Algeria, by M. H. Soulié.—On the treatment of black rot, by M. A. Prunet. Mildew and black rot being different diseases the same remedies should not be applied to both. The maximum interval which should be allowed to elapse between two successive treatments with the copper sulphate solution has been determined experimentally.—On the lower Gothlandian of the Armorican *massif*, by M. F. Kerforne.—Some facts, new or little known, concerning the Glacial period, by M. David Martin.

NEW SOUTH WALES.

Linnean Society, May 28.—Mr. J. H. Maiden, president, in the chair.—Descriptions of new genera and species of Lepidoptera (Fam. Noctuidæ), by Dr. A. Jefferis Turner.—An ascobacterium from the sugar cane, by Mr. R. Greig Smith.—Preliminary note on the geology of the Queensland coast, with references to the geography of the Queensland and New South Wales plateau, by Mr. E. C. Andrews. An attempt is here made to refer the origin of the present coastal configuration of Queensland and Northern New South Wales primarily to a recent variable crustal movement. The topography of the Cordillera and the continental shelf is found to throw light on Barrier Reef problems.—Notes on the botany of the interior of New South Wales (part vi.), by Mr. R. H. Cambage. The conspicuous botany of the country between Marsden, near Lake Cowal, and Narrandera is described. Mention is made of the damage done to certain trees, notably dogwood (*Myoporum deserti*), by the rabbits.

CONTENTS.