THURSDAY, MAY 28, 1903.

THE ERUPTIONS OF MONT PELÉE.

Mont Pelée and the Tragedy of Martinique. By Angelo Heilprin. Pp. xiii + 335. (Philadelphia and London: J. B. Lippincott Company.) Price 15*s.* net.

THERE have been not a few greater catastrophes than that in which the city of St. Pierre was annihilated, and all its inhabitants (with only one or two exceptions) killed in a few minutes, but the peculiar circumstances of that tragedy have combined to bestow on it a great amount of interest. The city was one of the fairest in the western hemisphere, and no less famous for its profligacy than for its beauty. The suddenness with which it was destroyed, the awful circumstances with which this was attended, and the strange and almost unprecedented nature of the calamity have all combined to lend it a peculiar horror. At first the newspapers were filled with lurid and incoherent accounts of what had taken place, and all manner of exaggerations regarding the condition of Martinique were mingled with the most gloomy forebodings regarding the future of the island. In course of time a more rational spirit prevailed, but it is perhaps even yet too soon to expect a calm and entirely scientific study of all the remarkable features of the catastrophe.

Meanwhile the facts are being carefully sifted by various scientific men, and to the brief reports already published by Prof. R. T. Hill, Mr. E. O. Hovey, and the Commissioners of the French Academy of Science, this most interesting volume by Prof. Heilprin is a very welcome addition. In many ways the author of this book combines the qualifications necessary for successful treatment of the subject. He is an eminent naturalist, a much travelled geographer, and to his scientific knowledge he adds a dauntless courage which has enabled him to face calmly all the dangers of the dreaded volcano of Martinique. The book, moreover, is written in a style so graphic and vigorous that the reader is carried along in breathless interest, and no one who can enjoy a thrilling tale of adventure, however little he may be interested in scientific theories about volcanoes, could possibly put it down until he had reached the concluding page. The photographic illustrations are excellent. Many of them have been taken from Prof. Heilprin's negatives; others are from other sources, and have already appeared in the newspapers.

To those who have followed carefully the history of the eruptions, there is a great deal in the book that is not new. Much of it has appeared already in magazine articles by Prof. Heilprin and other writers, but even when following a well-worn path, the author is never dull, and his *résumé* of the earlier accounts is valuable, if only because he was one of the first scientific men to reach the island after the tragedy, and had in consequence special facilities for sifting the evidence before that rank growth of misstatement and exaggeration, which rapidly sprang up, had time to reach its full development. This, however, is merely the prelude to his tale, and the interest deepens when he describes the efforts he made to obtain a view of the crater near the summit of the mountain, and to study the processes at work there. He was the first to reach the actual summit after the tragedy of May, 1902, but luck was against him, and the mountain was veiled in mist; next day he returned, but still was unable to make out the details of the interior of the crater. In this he was not more unfortunate than other observers; we met a newspaper correspondent in Fort de France last year who had been five times on the top of Montagne Pelée, and had failed to secure a single photograph that would bear reproduction. As a matter of fact, those who would learn the condition of the crater should refer to the descriptions by Mr. Hovey and Prof. Lacroix, whose accounts are much clearer than those given in the book before us.

Though baffled, he was not defeated, and in the month of August Prof. Heilprin returned to Martinique to renew his investigations. He again ascended the mountain from its eastern base, and this time it is clear that he had a very narrow escape with his life. The volcano was very active, and was emitting a vast cloud of dust and casting great bombs for hundreds of yards from the crater. The descriptions of the scenes on the upper part of the volcanic cone are vivid, and to those who know with what suddenness the deadly black cloud can rise from the crater and sweep down the mountain slopes to the sea, it is evident that the party carried their lives in their hands. Not much information of scientific value was likely to be obtained in the circumstances, for it was impossible to approach sufficiently near the crater to see what was going on there. Prof. Lacroix has subsequently ascertained that what was at first regarded as an interior cone of ash is really a solid pillar of lava rising up from the bottom of the crater until it overtops the former summit of the mountain. The lava of Montagne Pelée, in fact, is so viscous and so nearly consolidated that it is being forced out as ice or lead can be forced through a narrow orifice under great pressure. So long as it is in its present condition it cannot possibly flow over the ground, and when the steam within it expands the mass is in large part shivered into dust.

The second fatal eruption of Pelée, that in which the village of Morne Rouge was destroyed and 2000 lives were lost, took place when Prof. Heilprin was residing on the mountain. His narrative of the events is wonderfully graphic, and though the fatal cloud was discharged at night, and in the darkness it was not possible to see exactly what happened, it is quite certain that the eruption was of the same type as that in which St. Pierre was levelled with the ground. Next day Prof. Heilprin visited the scene of the disaster and interviewed the survivors. Their experiences seem to have been very similar to those of the inhabitants of the Carib country of St. Vincent during the great eruption of May 7. The chapters of this book in which the story of this eruption is recorded are a very valuable contribution to the scientific history of the activity of Montagne Pelée.

The concluding chapter, in which the phenomena of the eruption are discussed, is in some ways not the least interesting in the book. From it we learn that

the author has discarded his bizarre hypothesis that the black cloud consists of "carbon gases" produced by the distillation of beds of asphalt in Tertiary deposits beneath the volcano. He is now of the same opinion as other scientific men, viz., that the main constituents of the cloud were steam, hot dust and sulphurous acid. We can hardly pass without remark his extraordinary calculations of the amount of dust ejected by Montagne Pelée during the latter part of 1902. He arrives at the conclusion that 480 millions of cubic feet of solid sediment have been discharged every hour, and is inclined to believe that this is an under-estimate. So far at least as regards that period when we were in Martinique in July, this is a wild exaggeration. For hours at a time the volcano emitted hardly a puff of steam; a casual visitor might never have suspected that the deep gully near the summit led into the crater; the amount of dust discharged was negligible. Yet this was the period immediately preceding and immediately following the eruption of July 9, which was one of the most important eruptions of last summer. When Prof. Heilprin adds, "We ask ourselves the questions—What becomes of the void that is formed in the interior? What form of new catastrophe does it invite?" we seem to hear the echo of the dire predictions which resounded in the colonial journals about twelve months ago.

JOHN S. FLETT.

EXPERIMENTS ON ANIMALS.

Experiments on Animals. By Stephen Paget. 1p. xvi+387. New and revised edition. (London: Murray, 1903.) Price 6s.

A BOOK which reaches a second edition in two years can do so only in response to some distinct demand, and such a demand is in itself no little recommendation as to its merits. The author of the book, Mr. Stephen Paget, was for twelve years secretary to the Association for the Advancement of Medicine by Research, and it was therefore his business "to know something about experiments on animals, and to follow the working of the (Vivisection) Act of 1876." He is therefore to a peculiar degree competent to write a book dealing with these subjects, and it is a matter for congratulation that the council of the Association above mentioned decided that the book should be written with a view to general reading. Though in this present edition all references to anti-vivisection societies and their methods are very wisely omitted, yet the obvious purpose of the book is to combat the misleading statements which these societies have disseminated broadcast amongst the uninstructed public, and to afford information concerning the results achieved by such experiments on animals, whereby the public may be enabled to judge for themselves as to the claims of the anti-vivisectors. To quote Lord Lister, who writes an introduction to this volume,

"The action of these well-meaning persons is based upon ignorance. They allow that man is permitted to inflict pain upon the lower animals when some substantial advantage is to be gained; but they deny that any good has ever resulted from the researches which they condemn."

Mr. Paget's object is therefore to convey to the general reader some idea of the inestimable advantages which have accrued to medical science from experimental research on animals. In the closing pages of the book, moreover, he points out that the vast majority of the experiments carried out at the present day in Great Britain involve no pain at all to the animals operated upon. The comparatively few animals subjected to painful experiment

"cannot be compared with the same number of horses, cattle, or sheep mutilated by breeders and farmers; for these mutilations are done, some of them, without any anæsthetic. They cannot be compared with the same number of pheasants or rabbits badly wounded, but not killed, in sport; for the animals thus wounded receive no subsequent care, and, if they are in pain, nobody puts them out of it."

To come to the actual contents of the book, we find that Mr. Paget devotes more than 200 pages to the consideration of experiments in bacteriology, but only 84 pages to experiments in physiology. It is to be regretted that the subject which forms the foundation of all medical science should be treated so cursorily, but in excuse it may be admitted that the practical importance of much physiological work is indirect, whilst that of bacteriological work is obvious and immediate.

In his account of experiments in physiology, Mr. Paget gives a concise *résumé* of certain chapters in the history of physiology. The circulation of the blood is treated rather more fully than other subjects, though Harvey's work receives but four pages of description and quotation. In the chapter on gastric juice, Mr. Paget very pertinently refers to the well-known case of Alexis St. Martin, in whom a permanent gastric fistula was produced by a gun-shot wound. Yet in spite of the numerous experiments made upon this man by Dr. Beaumont, no pain was experienced. Presumably, therefore, artificially produced fistulæ in animals are equally painless. In the chapter upon the nervous system, the important results obtained by Galen are described, and it is pointed out that the men who followed after him, though they worshipped his name, missed the whole meaning of his work through their neglect of the experimental method which he employed.

In his pathological chapters Mr. Paget gives a brief account of inflammation and suppuration, and then passes on to serum therapeutics. As the book is admittedly for general readers, it is a pity that no general introduction to this subject is given. The meaning of antitoxins and their method of preparation are nowhere described. The various chapters adduce a very copious body of facts as to the cure of diseases by serum-therapy and preventive inoculation, but the absolute necessity for experiments on animals, not only for the discovery and elucidation of the curative and preventive methods, but for the direct derivation of the immunising sera, is implied rather than clearly stated in so many words. In fact, it looks

rather as if the author had for the time being forgotten the primary object of his book, and had become so carried away by the intrinsic interest of his subject as to be oblivious to the fact that most of his readers must be entirely ignorant of the rudiments of preventive medicine. With this slight criticism we may pass on to enumerate some of the contents of this section. After chapters on anthrax and tubercle comes a very long one on diphtheria, in which an almost unnecessarily full list of statistics is given. In the chapter on rabies we have an admirable description of Pasteur's discovery and method of preparation of rabies virus. The cholera chapter is no less interesting. The plague chapter gives a detailed and most instructive account of the report of the Indian Plague Commission. Judging from the evidence adduced, this report seems unduly pessimistic, and one would have thought the commissioners entitled to go beyond their finding that "the method of serum-therapy is in plague, as in other infectious diseases, the only method which holds forth a prospect of ultimate success." In the typhoid chapter we are interested to learn that of the 12,234 officers and men forming the military garrison in the siege of Ladysmith, 1705 were inoculated against typhoid fever, and that amongst these the proportion of typhoid cases was only 1 in 48·7, whilst amongst the uninoculated it was 1 in 7·07. Still, there is nothing to indicate whether the inoculated were a fair sample of both men and officers, or were chiefly composed of the latter. The intensely interesting chapter on malaria and yellow fever gives an admirable epitome of the most important work done and results achieved in the elucidation of the cause and prevention of these diseases, and should be read by everyone who is compelled by circumstance to live near fever-haunted spots. Still other chapters deal with myxœdema, the action of drugs, and snake-venom, whilst the book closes with an account of the Vivisection Act and inspectors' reports.

H. M. V.

CHEMICAL TESTS AND THEIR DISCOVERERS. Tests and Reagents, Chemical and Microscopical, known by their Authors' Names. Compiled by Alfred I. Cohn. Pp. iii+383. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 3 dollars.

THE appearance of this volume reminds one of two opposite tendencies that are developing in the terminology of modern chemistry. On the one hand, and more particularly in the "organic" division of the science, the chemist nowadays eschews all trivial or popular terms for his compounds, and strives to find appellations for them which shall be not merely names to remember the substances by, but titles which, at least to the initiated, are more or less self-explanatory. This is very meet and proper, and indeed some such system is probably unavoidable. But the union of the titular with the descriptive, *mariage de convenance* as it is, often produces some very ungainly offspring. Under the writer's eye there lies a recent volume of the *Journal* of the Chemical Society, several pages of which are plentifully besprinkled with such "names" as Ethylbromoketohydroxydihydropentanthrenedicarboxylate, and this is by no means the worst example that could be cited. Mark Twain once remarked of certain German polysyllabic achievements that they were "not words, but alphabetical processions." Similarly one may say of productions like the one above quoted that they are not names, but descriptive sentences with the verbs left out.

On the other hand, the instinct for brevity—combined sometimes, perhaps, with a suggestion of hero-worship or a tinge of Chauvinism—has simultaneously asserted itself in the upgrowth of a kind of personal nomenclature for numerous things chemical and matters microscopical. We have A's test and B's process; C's reagent and D's reaction; E's "number" and F's "value"; G's theory and H's "law"; every month sees additions to the list; and of the making of these minor immortals there seems no end. Time was when the cognominal designation was a distinct convenience. Perhaps it is so still, but in proportion as the number of such titles increases their utility diminishes, and if the hyphenless monstrosities of organic chemistry are sometimes almost undecipherable from their length, the proper names have become confusing by their multiplicity.

These now need, in fact, a dictionary to themselves. So far as tests and reagents are concerned, such an aid is furnished by the present volume. It gives in alphabetical order many hundreds of proper names by which various chemicals and operations are more or less generally known, and after each name describes, usually in a few words, the essential features of the test or reagent with which the name is associated. Most of the matter has already been published serially by the compiler in Merck's Report, and the amplified instalments are now collected in a single volume, where they will be found very convenient for reference.

What chiefly strikes one on looking through the book is that its value would have been much enhanced by the inclusion of more references to original descriptions, of which, indeed, only a very few are actually given. The increased space required would, surely, have been amply compensated by the greater utility secured. On account of the condensed style in which the descriptions are generally written, they are apt to be sometimes obscure; indeed, their chief value in many cases is that of a reminder to one who is already more or less familiar with the operation described. A person who had never previously performed the experiments would often want more detail, but as to where he could obtain it the author gives him no inkling. Nevertheless, the book will be of service to the busy chemist or microscopist. It does not claim to be a complete record, but there is a good deal of information given, and it appears to be generally accurate in substance if sometimes awkward in expression.

An index of subjects closes the volume, and is rather a curiosity in its way, since the body of it is made up almost entirely of proper names. The book may well find a place with the compiler's "Indicators" on the shelves of the chemical laboratory, and will be found useful in the microscopist's workroom.

C. SIMMONDS.

OUR BOOK SHELF.

Dictionary of Philosophy and Psychology. Vol. ii. Edited by J. M. Baldwin. Pp. xvi+892. (London: Macmillan and Co., Ltd., 1902.) Price 21*s.* net.

THIS, the second of the three volumes of Prof. Baldwin's dictionary, completes the text, for the third volume is to consist wholly of bibliographies. As in the case of the first volume, many of the articles are of high merit, but the standard of achievement varies pretty widely. The editor has taken a very liberal view of the range of subjects that call for notice, with the result that the ground is very completely covered, and place is given to a considerable number of topics in physical and biological science which a generation ago would hardly have been mentioned in a dictionary of philosophy or psychology. Perhaps the most valuable articles are those written by Dr. Stout and Prof. Baldwin conjointly, and forming a fairly complete series of careful definitions of psychological terms. We should like to have seen recognised the claims of psychology to rank as an independent science, freed from its ancient bondage to metaphysical philosophy, and if all that pertains to psychology had been brought together in a separate volume it would have formed a more useful, because more manageable, work of reference for the psychologist. The treatment of some topics suffers through being distributed under many separate headings, *e.g.* social science is treated of under that heading, but also under social dynamics, social evolution, social philosophy, sociology, social ethics, &c. Other subjects, again, suffer through being treated by too many hands, working not conjointly, but separately, and with imperfect coordination, so that we even find definitions begun by one writer or writers and finished by another, and in some cases conflicting views within the limits of one article. This is especially the case in the long article on vision. The biographical notes are unsatisfactory, because so very brief, and we note some slight inaccuracies, *e.g.* the description of G. H. Lewes as an English positivist, of R. H. Lotze as professor at Leipzig. These, however, are but small blemishes in a work that should be found very useful, not only by the philosopher and general reader, but by all students of psychology and the other biological sciences. It is interesting to note that "psychical research" receives formal recognition as a legitimate subject for study and research by the inclusion of several excellent articles from the pen of Mrs. Sidgwick.

How to Attract the Birds. By Neltje Blanchan. Pp. 244; illustrated. (London: W. Heinemann, 1903.) Price 5*s.* net.

WHETHER the author of this book should be addressed as Mr., Mrs., or Miss, and whether the name which appears on the title-page be real or assumed, we cannot determine, but we have little hesitation in saying that this and other works by the same pen have a charm and a freshness by no means apparent in all the bird-books which have come under our notice. Although written in America, and treating solely of American birds, the present work, like its predecessors, can scarcely fail to appeal to the English reader and bird-lover; and many of the hints given as to the best mode of attracting and keeping birds in gardens and plantations on the other side of the Atlantic will be equally applicable in the case of our native British species. On one point the author is very emphatic—namely, the impossibility of getting a large number of shy and attractive birds to frequent and build in a garden when a cat is also kept on the establishment. Not only are such attempts unsuccessful, but they are also cruel. In America, where garden crops and produce suffer perhaps even more damage from insects than is the case in this country, the small expenses connected with populating an estate with birds are more than compensated by the accruing advantages to fruit and flowers by the destruction of insect life.

"One pair of chickadees (whatever these may be) in an orchard," writes the author, "will destroy more insect eggs than the most expensive spraying machine." Apparently, indeed, the author will not allow that any bird can do harm in a garden; but then he (or she) has probably never seen a flock of bullfinches in a gooseberry plantation, or witnessed the mischievous devastation inflicted on a primrose-border by sparrows!

An attractive feature of the book is, of course, the numerous, and for the most part exquisite illustrations, more especially those of nests and eggs. In the case of some of the adult birds represented in foliage, we have a shrewd suspicion that they have been "faked up" by means of stuffed specimens, but even then the general effect is in most cases good. While devoting much attention to the proper subject of the book, the author by no means omits reference to the scientific aspects of ornithology, and the observations with regard to the white "recognition marks" on the loins of birds like our own wheatear are worthy of all attention. As a whole, Neltje Blanchan's latest work may be pronounced a charming and attractive volume. R. L.

Telephone Lines. By W. C. Owen. Pp. xvi+390. (London: Whittaker and Co., 1903.) Price 5*s.*

THIS book deals in a thoroughly practical manner with the construction and erection of overhead telephone lines and the laying of underground cables. The author's long experience as a telephone engineer enables him to write with authority on the subject, which he treats in all its important engineering aspects, from the best methods of preserving the wood used for poles to the final electrical testing of the finished line. American and continental practice is described as well as British methods. Telephony has always been regarded as a branch of applied science in which this country can by no means claim to be to the fore; the perusal of Mr. Owen's book certainly lends support to this belief, as the examples of continental methods which are quoted show in many instances considerable superiority. The theoretical explanations which are here and there required to show the necessity of certain methods of construction are expressed in clear and non-technical language well suited to linesmen and others who are not technical experts, for whom the book is largely written. A large number of illustrations help to explain the text; the book should prove very useful to those engaged in, or having anything to do with, telephone work, and may, moreover, be read with interest by all who care about the practical applications of science. M. S.

The Globe Geography Readers. Intermediate. Our Island Home. By Vincent T. Murché. Pp. 293. (London: Macmillan and Co., Ltd., 1903.) Price 1*s.* 6*d.*

IN the introductory and junior readers belonging to this series, already noticed in these columns, the young pupil is provided with simple explanations of the general principles underlying the study of geography; the present volume deals specifically with the physical and political geography of the United Kingdom in fifty-six short lessons, the subject-matter of which is varied and discursive, ranging from an account of the prehistoric inhabitants of Britain to a description of Irish scenery. The lessons are written in an interesting, conversational style, and are accompanied by an abundance of instructive illustrations, including sixteen coloured plates.

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.*]

Psychophysical Interaction.

I MUST demur to the statement of my views which Sir O. Lodge has given in his letter printed in NATURE for May 14, "that if dynamical laws are exact and irrefutable, the universe must be a completely determined mechanical system, with only one, and that a necessary, solution." In the first place, I made no statement as to the universe as a whole; as I do not know the physical universe to be finite in extent, I prefer to make statements only about finite portions of the universe, and the interactions of such finite portions. I certainly hold the view that the laws of dynamics, which are a self-consistent system of formal laws, are exact and irrefutable, but the question whether the motions of all parts of a living organism are in accordance with those laws is quite another matter, and one on which I have expressed no opinion. What I did in effect say, was that a material system upon which forces of psychical origin and of incalculable magnitude acted, traversed the laws of dynamics in the only sense in which such a system of laws can be traversed, viz. that the motions would not be in accordance with the laws, whether the supposititious forces do mechanical work or not.

Sir O. Lodge maintains that the psychical and the physical can interact without upsetting any fundamental dynamical law; he objects to the principle of Least Action as containing assumptions which beg the question at issue, and pins his faith to Newton's laws. Now, although the principle of Least Action contains nothing which is not deducible from Newton's laws, provided the same form of energy-function is taken in the two cases, I will, for the sake of argument, accept the test that Sir O. Lodge lays down. One of Newton's laws is that to every action there is always an equal and opposite reaction, or every stress has two aspects; now I suggest for Sir O. Lodge's consideration the following questions:—What are the reactions corresponding to the forces of psychical origin which act upon parts of a living organism? On what do such reactions act? It will clearly not suffice to say that the reactions are something of a different character from the actions, and are appropriate to exert an influence upon the psychical; Newton's reactions are mechanical forces acting upon material systems.

As an example of a mechanical system the motions of the parts of which are determinate through the laws of dynamics in conjunction with the law of gravitation, we may take the solar system, supposing each member of it to be treated as a whole. Let us suppose that there resided in the solar system some agency of a non-material character which was capable of applying to the planets forces of unknown magnitudes along the normals to their orbits relative to the centre of gravity of the system. The paths of the planets could then no longer be calculated; in fact, there would be an end of gravitational astronomy; both the linear and angular momenta of the system, so far from being conserved, would become absolutely indeterminate, and yet Sir O. Lodge must in consistency maintain that the laws of dynamics would not be traversed. Moreover, although the sum of the potential energy and the kinetic energy of the motions relative to the centre of gravity would be unaltered, the energy of the motion of the whole system through space would be altered to an unknown extent. If the disturbing forces acted normally to the paths relative to a point regarded as a fixed origin for the sun and stars, the energy of the system would be conserved, but in all other respects the same result as before would ensue, namely, chaos.

There are, I take it, in the main three views which may be maintained as regards the relations of the psychical and the physical in living organisms.

(1) The view known as pure naturalism, that the physical forms an independent system, and the psychical is only a *Begleiterscheinung* influenced by, or perhaps determined by, the physical, but exerting no influence on the physical. In this case the motions of the physical are entirely determinate in accordance with mechanical laws.

(2) The view that the psychical and the physical form two systems linked together, with interaction between the two; on this view neither system is complete in itself, and the physical cannot be determined completely by any system of purely mechanical laws. This view does not exclude pure determinism as regards the whole complex, since it may be held that the psychical has a dynamics of its own, and that the interaction between the psychical and physical is determinate in accordance with some scheme of laws.

(3) Lastly, it may be held that the dualism of the physical and psychical is entirely inadequate as an ultimate formulation; in fact, that both (1) and (2) are unworkable as thorough-going hypotheses; on this monistic view, both the physical and the psychical must be regarded as manifestations of something more fundamental than either. This view, as also (2), does not exclude the partial and tentative application of mechanical laws, even to the case of living organisms; there may be a partial or practical independence of the physical in certain classes or cases, but such practical independence could never be presumed apart from proof of its existence by means of actual observation, and there must certainly be a point at which the practical independence breaks down, and at which the dualism of our ordinary mode of thinking becomes inadequate as a representation of what happens. It is this last view of the matter which I am inclined, personally, to regard as the true one.

E. W. HOBSON.

Christ's College, Cambridge, May 17.

WITH the help of one of Clerk Maxwell's demons a very simple illustration of change of motion in a dynamical system, without any interference with the sums of energy and momentum, can be constructed, which may perhaps be of service to Mr. McDougall.

Let the demon provide himself with some inextensible, perfectly flexible, mass-less string. (It is found abundantly in text-books of Dynamics.) Let him observe two bodies of the system, having, it may be, motions of rotation as well as of translation; and when he discovers a point on each the relative velocity of which with respect to the other point is either zero or at right angles to the straight line between them, and which also are about to recede from each other, let him, at the very instant when things are so, attach a piece of his string to these two points exactly equal in length to the distance between them. The two bodies will thus be suddenly yoked together without any shock whatever, and consequently without any loss of energy. Their subsequent motions of translation and rotation will be altered by the action of the string; but their total energy and their total momentum will remain entirely unaltered. As soon as the string slacks the demon must be careful to remove it, in order to avoid the possible shock when it again tightens.

If the string be perfectly elastic (so that no energy is dissipated in internal work when the string stretches) instead of inextensible, the demon may attach it to any two points on the surfaces of the bodies without affecting the momentum sum or the energy sum; but so long as the string is at all stretched, a portion of the energy of the two bodies will be stored up in it.

For example, let the two bodies be spheres moving with the same uniform, rectilineal, velocity; and suppose the centre of figure of each to be its centre of inertia. Let each be spinning about an axis through its centre; perpendicular to the plane in which the centres are moving. Then the demon may safely fasten his inextensible string to the two points where the straight line joining the centres cuts the surfaces. There will be no shock, and therefore no loss of energy. There will be also no change in the total momentum of the spheres, whether linear or angular, nor any change in the uniform, rectilineal, motion of their common centre of inertia; nevertheless, when the demon releases them, they may be moving in divergent, instead of parallel directions, and with diminished or increased velocities of rotation.

Demoniacal guidance of this kind conflicts neither with the law of conservation of energy nor with that of the conservation of momentum, and so far would seem to contradict Prof. Ward's criticism in his "Naturalism and Agnosticism," vol. ii. p. 83.

J. W. SHARPE.

Woodroffe, Bournemouth.

PROF. MINCHIN raises the question of the desirability, or undesirability, of the use of adjectives with regard to physical principles. If the noun deserve the adjective, and if the meaning of the adjective be clear, it is not easy to see why the word should be omitted. Prof. Tait is cited, rather unfortunately, as the leader of those who apply the word "grand" to the principle of conservation of energy, while refraining from its application to certain other physical principles. Whether or not it be the case that "following his lead, all but the most sober mathematicians use the laudatory adjective when they write about this particular physical principle," it is certain that all but the least sober physicists will see a very real reason for the use of the term—precisely the reason which led Tait to adopt it.

Prof. Tait's use of adjectives is instructive. He made a very characteristic use of the term "mere," a word which Prof. Minchin would abolish along with "grand." He spoke of the mere mathematician, that is, a mathematical machine not possessed by the soul of a physicist.

But Tait did not refuse glorification to the principle of conservation of matter. He placed it, in that respect, on the same high level as the principle of conservation of energy. And he glorified Newton's laws, so glorifying the principle of conservation of momentum and the other principles alluded to by Prof. Minchin.

Tait also knew that it was possible so to state the principle of conservation of energy in a dynamical system as to make it include that of conservation of momentum. This was pointed out in an early chapter of a text-book on dynamics which he never completed.

Assume an origin and axes of reference. Let the (conserved) energy of a system be E_1, so that

$$\Sigma(mv^2) = 2E_1.$$

Assume that the energy is also constant ($=E_2$) when the motions are referred to an origin moving uniformly with speed a_2 in a direction making an angle θ with the line of motion of the mass m, and we get

$$a_2^2\Sigma(m) - 2a_2\Sigma(mv\cos\theta) = 2(E_2 - E_1).$$

Similarly

$$a_3^2\Sigma(m) - 2a_3\Sigma(mv\cos\theta) = 2(E_3 - E_2)$$

if we refer to an origin moving with uniform speed a_3 in the same direction. Hence

$$\Sigma(m) = 0, \quad \frac{\partial}{\partial t}\Sigma(mv\cos\theta) = 0.$$

The latter equation asserts conservation of momentum, the former asserts conservation of matter.

In the same way, if we postulate that momentum, found to be conserved when referred to certain axes and a given origin, is also conserved when referred to an origin moving uniformly with regard to this reference system, we can deduce the principle of conservation of matter.

It is impossible that all three—matter, momentum, and energy—can be in general found to be conserved simultaneously when referred to an origin in varying motion. If matter be conserved, and if we could measure, from our standpoint on the earth, the momentum and energy of the universe, we should find one or both to be subject to at least yearly, monthly, daily, &c., periodic variations. If the origin move with the centre of inertia, as in all cases directly experimented upon, all three principles hold if two hold, while the energy is found to be constant in at least one state of motion of the centre of inertia, say zero. The discussion of absolute conservation is as futile as the discussion of absolute motion.

It may be that energy, or momentum, is only conserved on the average as to space and time, the departures being on an ultra-measurable scale and yet sufficient to account for "guidance" action in living beings. But we do not require to postulate this in order to account for guidance action. Such action might occur and yet be in accordance with conservation of both momentum and energy. Maxwell's demons could bring it about. Suppose that the mass of a demon is zero, that he is perfectly elastic, and that his parts are capable of rapid relative motion. Let an army of such demons receive orders to abstract heat from one portion of a body and give it to an adjacent portion, so as to establish a difference of temperature while keeping the total energy constant. Because of his zero mass, each demon must adjust himself, in acting upon molecules, so as to produce zero change of momentum at any instant. He can allow quickly moving molecules to pass in one direction, slowly moving molecules in the other, while he prevents to some extent the reverse process. He might thus work railway points with no expenditure of energy on the whole, and with no change of momentum on the whole. The only principle temporarily interfered with is the principle of dissipation of energy; and that is temporarily interfered with constantly in nature.

Such speculations are of no value except as showing that guidance action *may* occur without overthrowing accepted dynamical principles. Further discussion lies outside physics. As Tait said, "human science has its limits, and there are realities with which it is altogether incompetent to deal." A sufficiently wide Monism is scientific and good.

W. PEDDIE.

University, Edinburgh.

IN his letter on the conservation of energy (p. 31), Prof. Minchin holds that, while energy might be conserved in the physical universe acted on in some way by mind, yet neither force nor momentum would be. "They" (the causes altering the configuration of a system) "infallibly alter its total momentum and total force in every direction."

Even for changes produced by physical causes, *e.g.* the pressure of a smooth rail, this may not be the case. It is true the rail will not guide a moving body along it unless it exerts pressure, and then it will generally alter the momentum of the system, to which the rail itself is not supposed to belong. It may happen, however, that the pressure from without is exerted in equal amount in opposite directions. Further, if it were true that the total momentum would be infallibly altered by a *physical* cause this would prove nothing for psychophysical action, unless we beg the whole question, and assume at the outset that the motion of matter can only be affected by what is material.

The constant use of physical analogy in this connection soon leads to obscurity. The only resemblance that can at present be said to exist between the action of mind and that of an ideal immovable rail is that both do no work. To explain *how* mind acts on matter, such analogies are useless. At most, in the case under discussion, they can only serve to show that there are possible causes of change which do not affect the energy. It is only, I think, an undue use of physical analogy—the action of the mind, for instance, being thought of as pressure—that can prompt the statement that any cause of change must alter the total momentum in some direction.

The laws of mechanics are merely regulative, and are not of themselves sufficient to account for the motion of a dynamical system with given initial conditions, unless it is stipulated that all action is mechanical, or at least unless the action on, or interference with, the motion is exactly defined. This is proved by the simple fact that we can solve examples in dynamics in which we suppose arbitrary, known interference to take place. In such examples, as a rule, the momentum of the system would be altered, but that is not at all necessary.

In conclusion, then, it may be agreed that the action of mind does not violate the laws of mechanics, but that no more prevents mind producing changes than it prevents those produced by ordinary mechanical action.

The University, Birmingham. C. T. PREECE.

Extension of Kelvin's Thermoelectric Theory.

LORD KELVIN'S thermoelectric theory has always seemed to me to be one of his best works. Since its enunciation the scope of the electric current has been extended, as in Maxwell's theory. It is now the curl of the magnetic force of the field always and everywhere. A corresponding extension of the thermoelectric theory is needed. I do not know whether it has been done, but it may be shortly stated, and contains some striking results. As regards the necessity, the following case will show it plainly. Make up a circuit of two parallel wires of different materials, both thermoelectrically neutral, say one of lead, the other of one of Tait's alloys. The places of thermoelectric force in the circuit are then the terminals. Now send short waves along the circuit, in the way so often done of late years. There need be no current at all in the circuit at one end to pair with that at

the other. So there is complete failure of the theory of metallic circuits.

But the needed extension is easily made by following Lord Kelvin's method, and using the enlarged meaning of electric current. Let **e** be the intrinsic voltage per unit length due to reversible thermal action, and let **C** be the current density. Then **eC** is the heat per unit volume absorbed per second, and the second thermodynamic law requires that $\Sigma \mathbf{eC}/\theta = 0$, if θ is temperature, the summation to be complete as regards **e**. Here **C** may be any circuital current, so $\mathbf{e} = -\theta\nabla p$, where p is a scalar, the thermoelectric power. In a homogeneous conductor, p is a function of the temperature only, to suit Magnus's results. But it is also a function of the material. In what way is not known, but it shows itself at the junction of different metals. Then p changes, say, from p_1 to p_2, so the intrinsic voltage at the junction is $P_{12} = \theta(p_1 - p_2)$. This is the Peltier force from the first to the second metal. So far is all that is necessary for steady currents. But when the current varies, part of it leaves the metals. Now at a metal-air junction, the thermoelectric power falls from p to 0, so there is an additional thermoelectric force **PN** or $p\theta\mathbf{N}$ acting outwards, **N** being the unit normal. It is here assumed that the thermoelectric power of air is zero. It does not seem likely that its value is important compared with p in a metal. This **PN** multiplied by the current leaving the conductor measures the reversible thermal effect at the boundary. The system is now complete, provided there is no external **e**. But should there be, then it must be counted too, if, for instance, a current is induced in an external conductor. In any case, $\mathbf{e} = -\theta\nabla p$ will be valid, with the usual proper interpretation of discontinuities, and the Maxwellian meaning of the current.

It will be sufficient to suppose that $p = 0$ outside a circuit of two metals. Then there is the Thomson force in the metals, the Peltier force at the metal junctions, and the metal-air force **PN** of variable intensity all over the circuit. In the extreme case with which I commenced, there may be only one Peltier force in operation, or even none at all, but just the metal-air force alone. If so, there is reversible evolution of heat at some parts, and absorption at other parts of the boundary.

As regards the application of the second thermodynamic law, it seems to be justified by experimental results with steady currents. I see no reason why it should not be applied to variable currents, even when varying very rapidly. For p is a property of the material and its temperature at any place, and has nothing to do at the moment with what is going on at other places. Yet a reservation is necessary. For the second law results from averages. So there must be some limit to the rapidity with which the current at any spot may vary, if the second law is to be fully valid there.

The Volta contact force must not be forgotten in connection with the metal-air thermoelectric force. Mr. J. Brown has lately made the Volta force disappear by heating it away in oil. If this is fully confirmed, it perhaps proves that chemical action between the metal and an electrolytic film of moisture is the real source of the energy of the transient Volta current, as Mr. Brown maintains. How will this affect the thermal force? If we allow properly for the change in p in passing through the film from the metal to the air, it seems likely that the thermoelectric effects will be simply superposed upon the Volta effects, because the sources of energy are different. Yet they might have to be combined in some unknown way.

Returning to the steady current in a circuit of two metals, Lord Kelvin showed that the complete intrinsic voltage amounted to $\Sigma p d\theta$. This does not express the real distribution of intrinsic force in the circuit, and seems to have no meaning. But it has a curious interpretation, which is of importance in the extended theory. The necessity of the metal-air force is shown in another way. I have shown that the source of **H** in varying states is the curl of **e** everywhere. Here this is $\mathbf{f} = V\nabla p\nabla\theta$. It is zero in a homogeneous conductor, and also at the metal junctions, but has the boundary value $V\mathbf{N}\theta\nabla p$, which would represent the source of **H** if there were no metal-air force. But add on the curl of the metal-air force P**N** or $p\theta\mathbf{N}$. It is $-V\mathbf{N}\nabla P$, and the sum of the two is $-V\mathbf{N}p\nabla\theta$. Now this is also the curl of the fictitious intrinsic force referred to, that is, $p\nabla\theta$ in the metals only. So we come to this striking result, that Lord Kelvin's $\Sigma p d\theta$ in the metal circuit alone is a fictitious distribution which not only gives the same steady current as the real distribution of intrinsic force, but also gives the true **E** and **H** everywhere in variable states as well, provided the real intrinsic forces include the metal-air forces along with the Peltier and Thomson forces.

OLIVER HEAVISIDE.

May 18.

THE FARTHEST NORTH.

H.R.H. Prince Luigi Amedeo of Savoy, Duke of the Abruzzi, has given to the English-reading public a superb account of his great Arctic expedition.[1] Though he has fortunately adopted a smaller size of volume than his Imperial namesake, the Archduke Ludwig Salvator, devotes to his luxurious memoirs on Mediterranean islands, the book is still both ponderous and imposing. Although in octavo, it is as large as most quartos, and it is a credit to the publishers in every way. A royal opulence is reflected from the burnished pages, which reflect the light also so perfectly that at night it is impossible, without elaborate precautions, to prevent the image of the lamp-flame from concealing part of the text. The very fine half-tone reproductions of photographs with which the book is crammed profit by the quality of the paper. The portraits of Admiral Markham and Dr. Nansen, illustrating the introduction, are not, however, very happily chosen, and we miss a satisfactory portrait of Captain Cagni, the hero of the memorable journey to the farthest north.

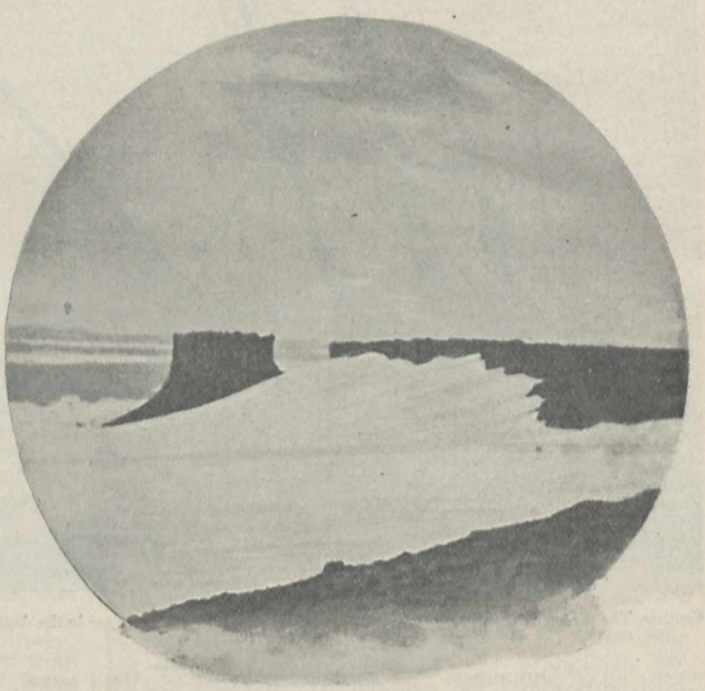


FIG. 1.—Cape Säulen, seen from the south-east. (From "On the *Polar Star* in the Arctic Sea.")

The royal author writes modestly and well, his

1 "On the *Polar Star* in the Arctic Sea." By His Royal Highness Luigi Amedeo of Savoy, Duke of the Abruzzi, with the Statements of Commander U. Cagni upon the Sledge Expedition to 86° 34′ N., and of Dr. A. Cavalli Molinelli upon his Return to the Bay of Teplitz. Translated by William Le Queux. In two vols.; with 212 illustrations in the text, 16 full-page photogravure plates, 2 panoramas and 5 maps. Pp. 702 + xxii + xii. (London: Hutchinson and Co., 1903.)

narrative occupying the first volume, and serving to show that he was a good comrade and a brave explorer, sharing all the discomforts of a somewhat miserable wintering without complaint. The translation, too, is well done, running so smoothly that it is rarely recognisable as a translation at all. Now and again, however, little bits of awkwardness come to light. A medical man would hardly write in English of the "digestive tube," nor would a sailor refer to the "left side" or the "chimney" of a steamer—"it's no a lum, it's a funnel," said "Wee Macgreeger" scornfully on one occasion. Trifles of nomenclature also show the want of first-hand knowledge; where the form is so beautiful it jars one to run against a "Thompson" compass, a "Clement" Markham, or

FIG. 2.—The *Polar Star* after the Ice Pressure. (From "On the *Polar Star* in the Arctic Sea."

even an "Ommaney." We wonder whether the British public nowadays attaches any more definite meaning to a dram as a unit of weight than it does to a gramme; and we are sorry for the task set to poor Dr. Cavalli in weighing out 8oz. 13·0958dr. of tinned meat for each man every day; though we are reassured in finding that the metric units quoted alongside prescribe only the quarter of a kilogramme, and we presume that he did not trouble himself to weigh it to the fifth of a milligramme as the English version suggests. This habit of translating foreign units by some theoretical table is so common that it is really time to put in a plea for the exercise of common sense, which in this case would suggest 8¾oz. as a sufficient equivalent for 250 grammes, and in another would delete a residuum of 4 drams in a weight of nearly a ton.

The narrative of the Italian expedition has already been summarised in NATURE (vol. lxiv., 1901, p. 158), and it need not be repeated. The first of the volumes before us supplies many additional particulars as to the first navigation of Queen Victoria Sea, and the long struggle with the ice before the *Stella Polare* reached the northern limit of the Franz Josef Land archipelago beyond Rudolf Island. It deals with all the usual incidents of a winter sojourn in high latitudes, made in this case unexpectedly hard by the party being obliged to leave the ship, which had been specially prepared for wintering in, and to camp instead in extemporised tents. There are few references to scientific work, but observations were made and collections obtained which are being discussed in a series of volumes by Italian specialists. Enough is said, however, to show that the observations must have been frequently interrupted. The difficulties of high wind and snowdrift proved much greater than were expected with regard to the meteorological instruments, in the management of which some preliminary experience at a high-level observatory in Europe would have been of great assistance. The magnetic hut, too, suffered from stress of weather; but we hope that the results obtained will yet prove of value.

Most interest naturally attaches to the second volume, which deals mainly with Captain Cagni's fine attempt to reach the Pole. This attempt proved more nearly successful than any sledging expedition before or since, and it is narrated by the captain himself. There is no doubt that if the commander of the expedition had sufficiently recovered from the serious frost-bite from which he suffered he would have led the advanced party to the farthest point. The pluck and endurance of the Duke of the Abruzzi have been amply proved, while the fact that when himself disabled he insisted none the less on his second in command carrying out the programme speaks volumes for his generosity and patriotism. The expedition was a private one, planned to gratify the laudable ambition of an illustrious personage, and no one could have reasonably objected if the commander had changed his plans and stopped the expedition when he found he could go no farther. Captain Cagni and the three Italian alpine guides who accompanied him were worthy of the confidence reposed in them, and they were rewarded by being able to carry the Italian flag a little nearer to the Pole than the flag of any other nation has yet been taken. Beyond observations of latitude, no scientific work was possible on this arduous journey; but the result showed clearly that, given a sufficiency of dogs, no piece of polar travel need prove too difficult for resolute men. The dogs of the *Stella Polare* not only drew the sledges, but, as in Nansen's case, they furnished a food-supply for their surviving comrades, and in this case towards the end for the explorers themselves. It is curious to find that the exhaustion of provisions, or even of the petroleum used for fuel, excited comparatively little interest so long as a few dogs were left to furnish

meat and grease to burn for cooking it; but the utmost anxiety was caused by the wearing out of the aluminium stove and cooking utensils. As regards clothing, the Italians found woollen material much more useful and satisfactory than furs. The point is discussed at some length by Dr. Cavalli, who observed that light porous cloth allowed the perspiration to pass to the outside before freezing, and there it could be scraped off and the clothes kept comparatively dry; whereas when skin clothing of any kind was used, snow and ice were formed on the inner surface, and when warmed in the sleeping-bag the clothes were saturated with moisture.

The Italian and Norwegian members of the expedition appear to have been on the best of terms throughout, and but for the loss of the first party returning from the great journey over the sea-ice, their year in the Arctic regions must be pronounced a most successful one. What is now wanted in the interest of science is no mere dash to the Pole, no more experiments as to modes of travelling, but a repetition of the drift of the *Fram* from a point north of Bering Strait, with abundant equipment for oceanographical, meteorological and magnetic research. It would cost but a trifle compared with the expense of an expedition with dogs and stores enough to ensure reaching a very high latitude from any land base, and the value of the results is certain, though five years might not be too much to allow for obtaining them. It is a great opportunity, ready for some wealthy person with a love of solitude and science.

THE RESTORATION OF THE LAND OF CHALDEA.

TWO lectures by Sir William Willcocks, late Director-General of the Irrigation Works in Egypt, delivered before the Khedival Geographical Society at Cairo, have been published in a pamphlet,[1] a copy of which has been received. Sir William Willcocks, as is well known, is an enthusiast in irrigation matters, and has had a very large share in bringing Egypt to its present state of prosperity by the reorganisation of the canal and reservoir system, and in designing the new works that have recently been carried out at Assuan. The pamphlet under notice relates to the ancient country of Chaldea, which bears a great resemblance in its physical features to Egypt, the river Tigris being capable of performing the same functions as the Nile.

In view of the proposed Bagdad Railway, which will traverse this delta, the subject is of considerable interest. The author's view is that the resuscitation of the ancient canal system would create along the line of railway a country as rich as Egypt, the rent of which would pay for both railway and irrigation works, and leave a surplus "which only those can realise who have been in intimate touch with Egyptian Agriculture."

Bagdad lies at a distance of about 500 miles from the sea, measured along its course. From the city to the Persian Gulf is a country now completely desolate, but which formerly was one of the most fertile and populous districts in the world. Opis, situated on the banks of the Tigris, and which was at one time the wealthiest mart of the East, bears to the delta of the Tigris very much the same relation that Cairo bears to the delta of the Nile; and here were situated the head of the great canals which irrigated the delta. The great Nahrwan canal had its intake in this locality, and extended for a length of about 250 miles, feeding an immense number of subsidiary canals. This canal, for the first ten miles of its course, was cut through hard conglomerate rock to a depth of 50 feet, and was 65 feet wide, increasing lower down to 394 feet. These dimensions considerably exceed those of the largest irrigation canal in Egypt. It was described as late as 970 A.D. as flowing amid continuous and extensive villages, date groves, and well-cultivated lands, the whole region over an area of 4600 square miles containing a population, judged from the ruins left, that no spot on the globe could excel. Owing to neglect of the works the main stream of the Tigris became diverted, the old bed of the river silted up, and the ruin of the irrigation system became complete, and now the ruins of Opis and many other mounds of adjacent buildings spread like islands over the deserted plain, which is quite bare of vegetation. The author of the pamphlet estimates that there are about one and a quarter million acres of first-class land of the value of 38,000,000*l.* that could be reclaimed and once more made prosperous by an outlay of 8,000,000*l.*, and which would produce a rental of 3,840,000*l.* Beyond this is an area of one and a half millions of acres of less fertile land, that could also be reclaimed and cultivated.

The second lecture is a description of what Egypt will be in fifty years' time, according to the author's ideas, when the country "will attain a height of splendour and magnificence." which will surpass the great works of the days of the Pharaohs, which have survived the revolutions and catastrophes of four thousand years.

[1] "The Restoration of the Ancient Irrigation Works of the Tigris; or, the Re-creation of Chaldea"; and "Egypt Fifty Years Hence." By Sir William Willcocks. Pp. 71; with 10 plates. (Cairo: National Printing Department, 1903.)

THE DALTON CELEBRATIONS AT MANCHESTER.

THE Manchester celebrations in connection with the centenary of Dalton's atomic theory began on Tuesday afternoon, May 19, when Prof. F. W. Clarke, chairman of the International Commission on Atomic Weights, delivered the "Wilde" lecture on "The Atomic Theory" to the Manchester Literary and Philosophical Society. Addresses were presented on behalf of the Royal Society and the Chemical Society, and a message was received from the Russian Physico-Chemical Society. In an admirable discourse Prof. Clarke sketched the history of the atomic theory from its first conception in the minds of Greek philosophers down to the present day. He pointed out the directions in which the atomic theory would probably develop, but declared that the problem of matter would never be solved until the atomic weights of the elements had been finally settled. "Who," he asked, "will establish the Dalton Laboratory for pure research, and so give the work which he started a permanent home?"

In the evening the Literary and Philosophical Society gave a dinner, at which the principal guests were Profs. Clarke and van 't Hoff, Prof. A. E. Armstrong, Mr. Brereton Baker, Prof. P. F. Frankland, Mr. Vernon Harcourt, Dr. Harden, Sir James Hoy, Prof. Kipping, Dr. W. H. Perkin, sen., Sir William Ramsay, Prof. Emerson Reynolds, Sir Henry Roscoe, Prof. Smithells, Dr. Scott, Prof. Thorpe and Prof. Tilden.

In proposing the toast of the evening, the "Wilde" medallist—Prof. Clarke—and the Dalton medallist—Prof. Osborne Reynolds—Sir Henry Roscoe said that Dalton's atomic theory and Joule's discovery of the mechanical equivalent of heat reflected more distinction on Manchester than the city's association with the cotton industry or with the Ship Canal.

On Wednesday morning a special meeting of the Owens College Chemical Society was held to offer an address to the great Dutch chemist, J. H. van 't Hoff, now professor at the Berlin University. Prof. Dixon

was in the chair. The address was presented by Mr. Norman Smith, a former student under Prof. van 't Hoff. The professor, who was enthusiastically received, said the question was often asked, nowadays, whether the atomic theory had not outlived its utility. His reply was that, in dealing with natural phenomena, with states of unstable equilibrium, the atomic theory was indispensable for essential explanations. He had come to regard the conception of the carbon atom as the centre of a tetrahedron as childish, but it contained the germ of a profound truth, the solution of which must be left to the future. He suggested that valency was due to an equilibrium. The four mutually repellent "electric atoms" of Helmholtz were kept in equilibrium by their attraction for the carbon atom at the centre.

Later in the morning Earl Spencer, Chancellor of the Victoria University, conferred the honorary degree of Doctor of Science on Prof. Clarke and Prof. van 't Hoff, who were presented by Prof. Dixon. After the conclusion of the ceremony Prof. van 't Hoff laid the

Memorial Tablet over door of house in which John Dalton was born. From a photograph supplied by Mr. A. Humphreys. The inscription on the tablet reads:—"John Dalton, D.C.L., LL.D., the Discoverer of The Atomic Theory, was born here Sept. 6, 1766. Died at Manchester July 27, 1844."

first stone of the proposed extension of the Owens College Chemical Laboratories, and was presented, as a memento of the occasion, with a silver trowel by the College Chemical Society. The celebrations were concluded by a soirée held at the Owens College on Thursday night, when Dr. Harden gave an interesting account of John Dalton, and many Dalton relics were exhibited by the Manchester Literary and Philosophical Society, Prof. H. B. Dixon, Mr. Theodore Neild, Mr. G. W. Graham and Mr. G. S. Woolley. E. C. E.

THE ATOMIC THEORY AND THE DEVELOPMENT OF MODERN CHEMISTRY.

MANCHESTER celebrated last week, just a little prematurely, the centenary of John Dalton's atomic theory. It was on September 6, 1803, that he drew up in his notebook his first table of weights of the "ultimate atoms" of hydrogen (which he took as his unit), oxygen, "azot," carbon, sulphur, and of water, ammonia, nitrous gas, nitrous oxide, and other binary compounds of these elements. With regard to the genesis of the theory in his own mind much doubt has prevailed until recently. Dalton himself told Thomas Thomson in 1804 that he had been led to the theory from his work on marsh gas and olefiant gas. He told W. C. Henry in 1824 that his speculations were suggested by the work of Richter. And yet, oddly enough, as Sir Henry Roscoe and Dr. Harden have shown in their "New View of Dalton's Atomic Theory" the evidence is dead against the accuracy of these plausible statements. Dalton's own notebook shows that his atomic theory preceded his work on marsh gas, and his notes for a lecture delivered in 1810 give a history of his ideas which agrees with all the facts.[1]

It was from Newton that Dalton derived his belief in the atomic hypothesis. And we can trace the "solid massy, hard, impenetrable, moveable particles" of Newton, through his friend Boyle, through Gassendi, and through Bacon (who considered Democritus to be the greatest of Greek philosophers) back to Epicurus and to the originators of the atomic theory, Democritus and Leucippus. Dalton's theory of atoms is historically the Greek theory of atoms. But with a difference.

Boyle, who was a far more thoroughgoing atomist than is generally supposed, really rejects the hypothesis of different elements which he himself originated, considering that differences of atomic structure and arrangement of a single form of matter would account for all chemical transformations.[2]

But Boyle's own definition of an element, as a substance which could not be decomposed, proved far more fruitful than his atomic beliefs, and the work of his successors—of Marggraf, of Black and Cavendish, of Scheele and Bergman, of Priestley and Lavoisier—had gradually established in the minds of chemists the idea, rejected by Boyle, that there existed a series of elements not convertible into one another. It was to that series of elements, unknown to the ancients, that Dalton applied the atomic hypothesis. He came to the conclusion that the atoms were not of all kinds of shapes and forms, as had been previously supposed, but that the atoms of the same element were all identical in weight, while the atoms of different elements were different in weight. It was an idea that might conceivably have occurred to some chemist fifty years earlier. But, in spite of Black's work, the phlogiston theory had led chemists before Lavoisier to lay small stress on the notion of weight. Dalton could hardly have come much earlier than he did. The first announcement of his theory was made in a paper read in October, 1803, at a meeting of the Manchester Literary and Philosophical Society, in the house of which he had his laboratory; the paper was not published until 1805. Dalton's views were not fully placed before the world until the publication of the first volume of his "New Systems of Chemical Philosophy," in the years 1808–1810.[3]

Meanwhile Dalton had been carrying out researches which confirmed his view, and, together with certain assumptions, led to the most important of generalisations. Dalton himself never disengaged the

[1] Save for an obvious clerical error of 1805 for 1803.

[2] "I see not, why we must needs believe, that there are any primogeneal and simple bodies, of which, as of pre-existent elements, nature is obliged to compound all others. Nor do I see why we may not conceive, that she may produce the bodies accounted mixt out of one another by variously altering and contriving their minute parts, without resolving the matter into any such simple or homogeneous substances, as are pretended" ("The Sceptical Chymist," part vi., folio edition, vol. i., p. 369). See also p. 366, a reference to an experiment by which Boyle thought he had "destroyed refined gold and brought it into a metalline body of another colour and nature"; and p. 367, an earlier announcement of the view just quoted.

[3] The first part of this volume appeared in 1808, the second in 1810. The first part of the second volume only appeared in 1827. The work was not completed.

facts from the theoretical language in which he clothed them. But we may say, broadly speaking, that Dalton's atomic theory led to the establishment of three fundamental laws of chemistry, the law of definite proportions,[1] the law of multiple proportions (which really includes the law of definite proportion) and the law of equivalents. The fact that elements unite in more than one ratio by weight obviously made further assumptions necessary, over and above the atomic hypothesis, before any table could be drawn up of relative atomic weights. Dalton seemed to have felt no hesitation in making the assumptions that seemed to him convenient ("New System," part i. p. 214). But Wollaston, while giving Dalton's theory his powerful support, showed, in 1814, that Dalton's assumptions were arbitrary, and Wollaston's term "equivalent," which was regarded as implying no hypothesis, soon became a serious rival to the term "atomic weight." Davy, to whom (with Henry) Dalton had dedicated part ii. of the "New System" in 1810, gave Dalton's views a reception more than cool.[2]

Among the great chemists of the day, it was to Berzelius, who had already been trying to extend the quantitative work of Richter, that Dalton's views appealed most. But Berzelius, less imaginative, but more critical a thinker and more accurate a worker, than Dalton, saw that much remained to be done before the theory could be placed on a satisfactory basis. "I think," he writes to Dalton, "that we must let experiment mature the theory." Berzelius's admirable "Essai sur les Proportions chimiques" of 1819[3] gives the first critical account of the atomic theory, while the experiments recorded therein may be regarded as having first placed the laws of multiple proportions and of equivalents on a sufficiently wide basis to be regarded as generally valid.

Nevertheless, the conviction that chemistry could do quite well without the conception of atoms, and that the notion of "equivalents" was sufficient, grew steadily; between 1840 and 1850 Leopold Gmelin's system of equivalents came to be accepted almost universally.[4] It was the growth of organic chemistry and the confusions in organic chemistry which the "equivalent" conception was powerless to remove that restored the notion of the atom. From 1842 onwards Laurent and Gerhardt, those two Ishmaels of their day, fought indefatigably for the establishment of some consistent theory of organic compounds; and they reached consistency only by reviving the simple molecular hypothesis of Avogadro and Ampère.[5] This hypothesis gave them at once an experimental method for the determination of the relative molecular weights of all volatile compounds; and it gave them simultaneously a method for determining maximum values for the atomic weights of the elements therein contained, for obviously each molecule must contain at least one atom. But neither they, nor Cannizzaro later, were able to give any simple rule applicable in all cases to the determination of atomic weights. The atomic weight of carbon on which the reform of Laurent and Gerhardt pivoted was an exception to the rule of Dulong and Petit on which Cannizzaro, with general approval, has laid so much stress. But a hypothesis may be useful without being perfect. The atomic hypothesis in the hands of Wurtz, Hofmann, Williamson, Frankland, Kekulé, and Baeyer, and with the most brilliant and essential but involuntary help of Berthelot and of Kolbe, was the instrument which served to build up modern organic chemistry. It gave chemists an unforeseen mastery over the elements; the synthesis not only of the natural organic compounds, but of an infinity of new ones seemed to be brought within their reach. In this development Manchester had again played a part of first-rate importance. Frankland's theory of valency was based on his researches on the organometallic bodies carried out in the Owens College, where he was professor, and published in 1852. The exact *rôle* of Frankland's work on valency (neglected at first by most chemists) was this: it forced his friend and fellow worker, Kolbe, to abandon the Berzelius copula theory, and led him to build up "constitutional" formulæ for the chief alkyl compounds so near our own that he was enabled to predict from them the existence of secondary and tertiary alcohols. The formulæ of Kolbe, with the atomic weights of Gerhardt, again led inevitably to the great theories of Kekulé on the tetravalency of carbon and the linking of the atoms, which are now regarded as fundamental in organic chemistry.

In 1875, new horizons were brought into view. Wollaston predicted of Dalton's atoms in 1808 that "the arithmetical relation alone will not be sufficient to explain their mutual action, and that we shall be obliged to acquire a geometrical conception of their relative arrangement in all the three dimensions of solid extension." Le Bel and van 't Hoff, by their work on the "asymmetric" carbon atom, created a new "chemistry in space," of which one of the most striking results has been the beautiful synthesis of the sugars, by Emil Fischer and his fellow workers. Prof. Pope has recently extended these new ideas to inorganic chemistry with brilliant results.

But such exceptional results as those of Prof. Pope bring sharply into view the fact that the direct service of the atomic theory to inorganic chemistry has been relatively small. What, for instance, has the theory of valency to tell us about such a series of compounds as the tungsten chlorides discovered by Roscoe? But if the atomic theory has helped us comparatively little in determining the constitution of inorganic compounds,[1] it has contributed to our discovery of new inorganic elements. The attribution of certain numbers, equivalents or atomic weights, to the elements led naturally to speculation on mathematical relationships between them. Many of these speculations, like the original one of Prout in 1815, and that of Dr. Henry Wilde, of Manchester, more recently, were suggested by the fascinating question of the fundamental unity of all matter. Are the elements really compounds of one original matter—the *protyle* of the Greeks revived by Prout and by Sir W. Crookes? If so the atomic weights must have some common measure. On the accurate determination of atomic weights, made largely to settle this question, infinite pains have been spent by Stas, Marignac, Richards, and many others. On the criticism and accurate calculation of results from these experimental determinations infinite pains have again been spent, by Meyer and Seubert, and above all by Prof. F. W. Clarke, who delivered the Wilde lecture of the Manchester Literary and Philosophical Society at the centenary celebrations last week.

But though certain numerical relations seem striking, chemists are certainly as a body not inclined to acknowledge the existence of any exact formula expressing as a mathematical series the series of the atomic weights.

More immediately fruitful of results have been speculations less fundamentally ambitious. The schemes of Lothar Meyer and Mendeleeff, according

[1] The present writer has briefly discussed the history of this law, in NATURE, vol. l. 1894, p. 149.

[2] In two unappreciative lines in a footnote to the "Elements of Chemical Philosophy," published in 1812 (see p. 78 of the edition of 1860).

[3] The Swedish edition appeared earlier.

[4] Gmelin himself in his "Handbook of Chemistry" inclined to the atomic theory. English edition, translated by H. Watts, vol. i. p. 42.

[5] "Equal volumes of all gases under the same conditions of temperature and pressure contain equal numbers of molecules."

[1] The researches of Divers and of Raschig on certain sulphur and nitrogen compounds may be regarded as examples of what may be done in this direction.

to which the elements, when arranged in the order of their atomic weights, take their place on a kind of chessboard, elements resembling one another being in the same row, have led to the prediction of the existence of new elements; and even unpredicted new elements, such as the remarkable series discovered by Lord Rayleigh and by Sir William Ramsay, have had a fairly comfortable place found for them by extending the chessboard on ground to which it had some legitimate claims.

Inorganic chemistry has developed recently very largely on the physical side. In much of the work, notably in the applications of thermodynamics (and especially of the researches of Willard Gibbs, whose death we lament), the atomic theory plays no part, or but a small one. In the great studies on solutions, however, originated by van 't Hoff, Arrhenius, and Ostwald, the fruitful *ion* theory formulated by these chemists can hardly be regarded as independent of the atomic theory. And yet, in his last book on inorganic chemistry, Prof. Ostwald employs "the forms of the atomic hypothesis as sparingly as ever the present use of language will permit."[1]

In what has preceded, the atomic theory has been regarded from the point of view of utility. Of its utility to chemistry there can be no doubt. It helps us to describe complicated phenomena briefly. The atomic formula $CH_3.COOH$ reminds organic chemists at a glance of a very large number of properties of acetic acid. But, many will ask, is this atomic theory something more than useful? Is it really true?

The subject has been much discussed of late both by men of science and philosophers.[2] One school regards the methods of experimental science as capable of yielding generalisations that are absolutely true, and some of the members of this school do not hesitate to say that the atomic theory is absolutely true. Sir Arthur Rücker concluded his brilliant address to the British Association in 1901 by declaring that "we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our (*i.e.* the atomic) theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities." Even in this most positive assertion of Sir Arthur Rücker with regard to the existence of atoms there remains a shade of doubt. Lord Kelvin, in a subsequent speech, showed that in his mind, at any rate, there was none.

There is, however, another school, the origins of which go back far, but which is identified chiefly with Kirchhoff (the discoverer with Bunsen of spectrum analysis), and with his disciples Mach and Ostwald in Germany, and Karl Pearson in England. According to this school, the discovery of "causes" and of ultimate truths is not the business of experimental science. The object of science, according to Kirchhoff, is to describe natural phenomena in the simplest way possible. If a theory like the atomic theory helps us to describe observed phenomena more simply and to discover new ones, let us use it by all means. But (they would say) since the existence of atoms cannot be verified directly,[3] it is really useless for scientific purposes to discuss whether the theory is true or not. Obviously, science here abandons those claims to finality which have been insisted on so strongly by the older and more orthodox school, for our simple descriptions are liable at any moment to be replaced by descriptions still more comprehensive and still more simple. It would be hard indeed to prove that any given theory has attained a maximum of simplicity in summarising the facts with which it deals.

Kirchhoff's self-denying ordinance on the part of science leaves, no doubt, a wider field open to the metaphysicians. But *qui trop embrasse mal étreint;* and the limitations of scientific claims which he advocates may well strengthen science in her own proper borders.

The atomic theory has had a long and venerable history; the "solid, impenetrable" particles of Newton were originated by the Ionian philosophers in the fifth century B.C. A hundred years ago the genius of Dalton gave the theory a fresh and still unfinished career of usefulness, and whether we consider it in the light of a truth that cannot ever disappear from science, or rather as an engine serving to fashion and unite our ideas, possibly to be replaced later by an intellectual mechanism still more efficient, our debt to Dalton remains one of the greatest that the world owes to its great men.

P. J. HARTOG.

[1] "Principles of Inorganic Chemistry." Translated by A. Findlay, 1902, p. 146. (Macmillan and Co., Ltd.)

[2] See Prof. James Ward's "Naturalism and Agnosticism," 2 vols., 1899.

[3] "No physicist or chemist can produce a single atom separated from all its fellows and show that it possesses the elementary properties he assigns to it" (Sir A. Rücker, *loc. cit.*).

NOTES.

A SPECIAL meeting of the Physical Society will be held on Friday, June 5, at 5 p.m., at University College, when Prof. Rutherford, of Montreal, will read a paper on radio-active processes. A discussion will follow, in which it is hoped several prominent physicists will participate.

IN reply to a question asked in the House of Commons on Tuesday, Mr. Balfour stated that the Government would contribute to the funds required to send the relief ship *Morning* to the Antarctic at the end of this year, to ensure the safety of the officers and men of the *Discovery*, now ice-bound in Antarctic seas.

THE ninth quinquennial conference of the States adhering to the International Telegraph Convention was opened on Tuesday by the Postmaster-General, Mr. Austen Chamberlain, M.P. The business of the conference will go on from day to day until the end of June. Mr. J. C. Lamb, C.B., C.M.G., the principal delegate of Great Britain, was chosen president of the conference, and Mr. John Ardron and Mr. P. Benton vice-presidents.

M. HENRI BECQUEREL, Paris, and Prof. A. Righi, Bologna, were elected honorary fellows of the Physical Society of London at the last general meeting.

THE *Daily Mail* announces that Mr. Andrew Carnegie has offered to subscribe 10,000*l.* towards the erection of an experimental tank for testing ship models, as a memorial to James Watt.

MR. ANDREW CARNEGIE has offered to give 200,000*l.* for a building for the American engineering societies. It is, says *Science*, to be situated in New York City, and will provide an auditorium, a library and headquarters for five engineering societies.

THE death is announced of Prof. C. A. Bjerknes, professor of pure mathematics at the University of Christiania, at the age of seventy-eight, and of Dr. G. C. Dibbits, formerly professor of chemistry at Utrecht, at the age of sixty-four.

THE death is announced of M. Félix Worms de Romilly, a former president of the French Physical Society, who served for many years on the council, and who in addition contributed liberally towards the cost of certain publications undertaken by the Society.

THE *Bulletin de la Classe des Sciences* (Brussels) announces the death, at the age of seventy-six, of M. Charles de la Vallée Poussin, professor of mineralogy and geology of the University of Louvain, and author of important geological papers published in the *Bulletin* itself

and in the *Annales* of the geological and scientific societies of Brussels.

A REUTER message from Stockholm, dated May 22, states that the expedition which is being fitted out to relieve the Nordenskjöld Antarctic Expedition will be provided with stores for three years. It will be under the command of Captain Gylden, of the Swedish navy, who was in charge of the expedition sent to Spitsbergen in 1901 for the measurement of an arc of meridian.

A CORRESPONDENT of the *Times* states that an earthquake was widely felt in Turkish Armenia on April 29. More or less severe shocks were experienced from Van to Baiburt, on the north-west, and it is feared that the loss of life has been extensive. So far no actual details as to the effects of the earthquake seem to have been received, except some relating to the military losses at a town about 100 miles north of Erzerum.

THE annual report to the Conseil de l'Observatoire de Paris, which M. Maurice Loewy is preparing for publication, will contain an account of the recent observations made at Greenwich and Paris for the determination of the difference of longitude between the two observatories. In each observatory a French and an English astronomer made observations independently in the spring and autumn of last year, and a Paris correspondent informs us that the discussion of the two series shows no sensible difference between the French and English results. When the calculations have been completed, the results will be described in papers to be presented at the same time to the Royal Society and the Paris Academy of Sciences by Mr. Christie and M. Maurice Loewy respectively.

THE Australasian Association for the Advancement of Science will hold its next meeting at Dunedin in January, 1904, under the presidency of Prof. T. W. E. David, of Sydney University. The sections and their presidents will be as follows:—A—astronomy, mathematics, physics, and mechanics, Prof. W. H. Bragg; B—chemistry, Mr. J. Brownlie Henderson; C—geology and mineralogy, Mr. W. H. Twelvetrees; D—biology, Colonel W. V. Legge; E—geography, Prof. J. W. Gregory, F.R.S.; F—anthropology and philology, Mr. A. W. Howitt; G—(1) social and statistical science, president not yet appointed; G—(2) agriculture, Mr. J. D. Towar; H—architecture, engineering, and mining, Mr. H. Deane; I—sanitary science and hygiene, Dr. Frank Tidswell; J—mental science and education, Mr. John Shirley.

THE annual congress of the South-eastern Union of Scientific Societies will be held at Dover, June 11–13. On Thursday evening, June 11, the president-elect, Sir Henry H. Howorth, F.R.S., will deliver the annual address. The following papers will be read on June 12:—Atmospheric moisture as a factor in distribution, by Mr. A. O. Walker; experiences of leprosy in India, by Dr. Jonathan Hutchinson, F.R.S.; the diminution and disappearance of south-eastern flora and fauna within the memory of present observers, by Captain McDakin and Mr. Sydney Webb; the seedlings of geophilous plants, by Miss Ethel Sargant; the white chalk of Dover, by Dr. Arthur Rowe; a late Keltic cemetery at Harlyn Bay, by Rev. R. Ashington Bullen. On June 13 Mr. A. T. Walmisley will lecture on international communication.

THE first section of the London County Council's electrical tramways, opened a few days ago by the Prince and Princess of Wales, is of special interest because in the electrification of this tramway the conduit system has been adopted instead of the overhead trolley system, which has been almost universally installed elsewhere throughout the country. The appearance of the line is unquestionably very much superior to that of lines equipped on the overhead system, but it remains to be seen whether it will work equally well in practice; for this reason the working of the new lines will be watched with special interest during the next few years. The cost of installing the conduit system has proved much greater than that of equipping an overhead system, and it is to be hoped that some other advantages will be found to result in working in addition to the gain in appearance, as the district can hardly be said to be one of such great natural beauty that overhead lines would have spoilt it.

THE Middlesex Hospital at the beginning of this year established a complete electrical installation for electro-medical work. The equipment includes all the necessary apparatus for X-ray work, high-frequency, Faradic and galvanic treatment. There are two Finsen lamps for the treatment of lupus, and experiments are also being tried in the treatment of this disease by the Cooper Hewitt mercury vapour lamp. The greater part of the apparatus has been set up in a special temporary building. This is already being found somewhat too small for the number of patients passing through, which amounts to about three hundred a week. Two trollies fitted with apparatus and coils for treatment and radiographic work have also been equipped. It is stated that the results obtained in cases of lupus have been most satisfactory, and that the X-ray treatment of cancer is also giving promising results. The high-frequency treatment of cancer has not been found as yet to justify the claims made in its favour, but further experience and observation are required.

A *Daily Mail* correspondent at Rome states that shortly before eleven a.m. on May 22, an earthquake shock was felt throughout Italy.

ROBINS frequently build in curious places. Miss E. M. Milner sends from Stafford a photograph of a robin's nest built in a small leather handbag that was hung in an arbor near her house. Five eggs were laid and hatched in this nest.

REFERRING to the discovery of a radio-active gas in water by Prof. J. J. Thomson (April 30, p. 609), and the demonstration by Prof. Rutherford that the emanation from radium and thorium is a gaseous body, Mr. W. A. D. Rudge writes to suggest that some interesting results might be obtained from the examination of the gases withdrawn from deep mines for the purpose of ventilation. Mr. Rudge also suggests that these radio-active gases may be of the nature of metallic carbonyls, "because they are the only known metallic compounds which are gaseous to any extent at ordinary temperatures."

THE Meteorological Council has issued a notice stating that it will, as before, supply forecasts of weather during the summer months (June to September inclusive) for the benefit of agriculturists and others as was arranged last year. These forecasts are sent by telegraph at about 3h. 30m. p.m. to those who express a wish to receive them regularly, and who defray the cost of the telegrams, which will be so worded that the cost of each message will be 6*d.* for any one district, including an address of three words. This service of harvest forecasts is, in addition to the ordinary service of forecasts, prepared at 11h. a.m. and 8h. p.m. The harvest forecasts refer to the weather of the next day.

INTERNATIONAL scientific balloon ascents were made on the morning of March 5; the balloons were both manned and others equipped with recording instruments only, while

at some stations kites were used. We quote only the preliminary results of the registering balloons, as these attained the greatest altitudes. At Trappes, near Paris, a temperature of −49°·8 C. was registered at 10,000 metres; the reading at starting was 9°·6, and an inversion of 0°·2 occurred at 750 metres. The balloon rose to 15,700 metres, but if readings at higher altitudes than those quoted are suspected of being vitiated by radiation, they are scrupulously rejected. At Strassburg, the temperature at starting was 6°·3, and the following readings were recorded:—−59°·1 at 15,600 metres, −54°·0 at 10,300 metres, −51°·5 at 12,200 metres. A second balloon, on March 6, recorded −62°·1 at 15,330 metres, −51°·2 at 10,200 metres, and −48°·2 at 11,300 metres. At Berlin the following temperatures were recorded:—−57°·0 at 10,400 metres, −51°·0 at 12,000 metres; at starting 4°·4. The type of weather was cyclonic over the British Isles and west of Scandinavia, and anticyclonic over south-west France and eastern Russia.

THERE has recently been some discussion in the columns of our contemporary *Science* as to who first made use of the word "barometer." It occurred in a paper by Boyle in the *Phil. Trans.* of 1666, and also in an anonymous article in the same journal in 1665. Our valued correspondent, Mr. A. L. Rotch, refers to the use of the word in 1665 in "The General History of the Air . . . by the Honble. Robert Boyle, Esq.," published in London in 1692. We have referred to the work and to the article in question, viz. "A Short Account of the Statical Baroscope, imparted by Mr. Boyl, March 24, 1665. In a Letter to Mr. H. Oldenburgh." As the matter may be of interest to our readers, we quote the sentence (p. 98):—"When I come to another Place, where there is a Mercurial Barometer, as well freed from Air as mine (for that must be supposed) if taking out my Scale-Instrument, it appears to weigh precisely a Drachm; and the Mercury, in the Baroscope there, stand at 29½ Inches, we may conclude, the Gravity of the Atmosphere, not to be sensibly unequal in both those two Places, though very distant."

DURING the summer months of the years 1900–1902, the cutter yacht *Walwin*, belonging to Dr. R. N. Wolfenden, was engaged, under the owner's direction, in taking sea temperature observations at the surface and at various depths, and in the collection of samples of water in the channel between the Shetland and Faëroe Islands. The discussion of the observations was entrusted to Mr. H. N. Dickson, who has communicated the results in an interesting paper to the *Geographical Journal* for April. There are two opposing movements of water in the channel, from the south and from the north. The former, or north-moving currents, are of two kinds:—(*a*) drift currents caused by the winds; these are strongest during winter; and (*b*) stream currents, or the Norwegian branch of the European stream; these are strongest during summer. The south-moving currents are also of two kinds:—(*c*) water from the central and western parts of the Norwegian sea, and (*d*) water derived from the melting of ice in the Arctic regions. One of the conclusions drawn by the author is that the movements of the surface waters of the sea and the temperature of the air near the British Isles do not stand in any direct relation of cause and effect. The temperature of the surface water influences the distribution of atmospheric pressure, and will therefore affect the direction of the prevailing winds, but motion has nothing to do with this influence.

AN exhibition of mounted heads of the larger mammals and other products of the chase from the German Colonies (Deutsch-Kolonial Jagd-Austellung) has lately been opened at Carlsruhe, under the patronage of the Grand Duke Frederick of Baden. More than fifty persons, who have been out in the German Colonies as officials or in quest of sport, have sent their trophies to it, and a most extensive and instructive series of specimens is the result, which no one interested in the larger game-animals should fail to see. The well-known traveller and naturalist, Oscar Neumann, has contributed the whole of his large African collection. Herr Carl Hagenbeck, of Hamburg, who has long been engaged in getting together a series of heads and horns from all parts of the world, has likewise sent the whole of them to Carlsruhe for exhibition. Amongst the latter the specimens of wild sheep, ibexes and deer from Central Asia have attracted much attention. The collection will be open to view all the summer in the building of the Jubileum Art Exhibition, at Carlsruhe.

CAPTAIN STANLEY FLOWER, the director of the Zoological Gardens at Gizeh, near Cairo, is expected to arrive in England about the end of this month, and will bring with him a valuable contribution to the Zoological Society's menagerie. This is a male Grévy's zebra, by far the largest and finest member of the group of African striped asses. There are already two female examples of this beautiful animal in the Zoological Society's Gardens, which have been placed under the Society's care by H.M. the King, so that the acquisition of a male of the same species is eminently desirable. The male in question was obtained for the Society by Colonel Harrington, the British Resident at the capital of Abyssinia, and was brought down as far as Cairo in December last. But it was thought prudent to keep the animal in a warmer climate during the winter season, so it was arranged to deposit it at Gizeh under Captain Flower's care. It is hoped that Captain Flower will likewise be able to bring to England on the same occasion another female of the same species of zebra, also obtained for the Zoological Society by Colonel Harrington.

AN important series of statistical articles dealing with the occurrence and incidence of cancer in various countries has been published in the *British Medical Journal*. The main conclusions arrived at are that cancer is prone to attack certain races, especially the Scandinavian and the different branches of the Germanic family, that it is more prevalent in districts in which beer is the staple drink, and that it tends to cause excessive mortality in regions abounding in water, and to a much more marked extent when these are covered with woods or forests.

THE well-known salmon disease, since the researches of the late Prof. Huxley, has always been regarded as being caused by the attack of a fungus, the *Saprolegnia ferax*. Recently Mr. Hume Patterson has conducted a research for the Fishery Board for Scotland, and has come to the conclusion that the disease is due to invasion of the tissues of the fish by a special bacillus (*B. salmonis pestis*), which gains access through some abrasion or ulceration of the skin. When the skin of the fish is in a healthy state, the disease is apparently not contracted. The bacillus remains alive in the dead fish, which therefore prove a source of infection, and should immediately be removed and burnt as soon as they are observed.

VARIOUS explanations have been given of the cause of the phenomenon of agglutination, the aggregation of the bacteria into clumps, that occurs when an immune serum is added to a bacterial culture. A substance termed agglutinin develops in the serum as the result of immunisation (also frequently during an attack of infective disease, *e.g.* typhoid fever), which combines with some constituent in

the bacterial cell. Dr. A. E. Wright suggests that this combination alters the electrical relations of the fluid and suspended particles (bacteria) so that these then offer an appreciable resistance. The electric currents generated by the ionisation of the salts in solution would tend to drive these interposed resisting particles out of the direct line of action, and the displaced particles would all tend to find a position of rest in the angles between the intersecting lines of force, and so clumping would result. (*Lancet*, May 9, p. 1299.)

MUCH work has of late years been carried out upon the nature and physiological action of the venoms of poisonous snakes. The latest contribution to the subject is a memoir by Captain Lamb and Mr. Hanna upon the venom of Russell's viper (*Daboia Russellii*). They find that Daboia venom owes its toxic property chiefly to its action upon the blood, the rapid death which results being mainly due to extensive clotting of the blood in the blood-vessels. Heating a weak solution of the venom (0·1 per cent.) for half an hour to 73° C. completely destroys the toxicity, though a more concentrated solution (1 per cent.) may have its toxicity only lessened by this treatment. Daboia venom and cobra venom differ in two respects; cobra venom contains a toxic substance of the nature of an albumose, which acts especially upon the central nervous system, and is the essential poisonous constituent, whereas it contains no substance causing intra-vascular clotting. Daboia venom, on the other hand, contains no toxic element having an action similar to that of the toxic albumose of cobra venom. Calmette's anti-venin, which has a powerful neutralising action for cobra venom, possesses little or no such property for Daboia venom. (*Scientific Memoirs of the Government of India*, No. 3, Calcutta.)

PART i. vol. iv. of the *West Indian Bulletin* contains a complete record of the observations of atmospheric phenomena at various points on the island of Barbados during the fall of volcanic ash following the eruption of the St. Vincent Soufrière on March 22 last, together with the results of the chemical analysis of the ash by Prof. d'Albuquerque, and of the mineralogical analysis by Dr. Longfield Smith. The latter states that the minerals present were the same as those found in previous falls, but the relative proportions differed very considerably, the most striking feature, which at once distinguish the late fall from former ones, being the large amount of magnetite and hæmatite present. There was only a small proportion of glass, which was of two kinds—a clear, colourless to brown variety, enclosing microlites and often crystals of felspar, and a translucent to opaque variety, the latter often brown, owing to numerous hæmatite inclusions.

THE Imperial Department of Agriculture for the West Indies is giving some attention to the question of improving the corn yield of the islands for estate purposes. At present enormous quantities of corn have to be imported, for the islanders grow corn only as a catch crop, which is often planted at wide distances apart, and little or no attention is given to it. As a result the yield of corn averages only about ten bushels per acre, the quality grown containing 10 or 11 per cent. of protein. In a recent number of the *Agricultural News* it is stated that much better results "may be attained without the aid of elaborate chemical analyses, and with no more apparatus than a pen-knife, an observant eye, and the expenditure of a certain amount of care and time." Based upon the investigations of Prof. Hopkins, of the University of Illinois, simple instructions are given for making a chemical selection of ears of seed-corn by a simple mechanical examination of the kernels, thus enabling farmers to separate the high-protein from the low-protein seeds. It is hoped by adopting this method of corn-breeding to increase the protein yield by about 2 per cent., while the greater care devoted to the cultivation would necessarily lead to a substantial increase in the quantity of corn produced per acre.

AN interesting account of the works of the late Sir G. G. Stokes is given by Prof. W. Voigt in the *Nachrichten* of the Göttingen Academy, 1903, part i.

THE Actien Gesellschaft für Anilin Fabrikation, of Berlin, send their price list of dry plates, developers, and other requisites for photography, which they manufacture under the registered name of Agfa.

CONSIDERABLE uncertainty has prevailed as to the existence of conjugation in the Amœbæ. In the *Atti dei Lincei*, xii. 7, Signora Margherita Traube Mengarini publishes a paper on the subject. The authoress has been sufficiently fortunate to observe a process of true conjugation in *Amœba undulans*, apart from the process of fusion observed by Zaubitzer and Maggi. This process lasts but a short time, and it ends in the complete separation of the animals, so it is difficult to study the phenomenon in its entirety.

IN connection with the debated question of the magnetic action of convection currents, MM. Crémieu and Pender have undertaken a series of experiments the results of which are summed up in the *Bulletin* of the French Physical Society. They now definitely prove that metallic surfaces turning in air, either with or without the presence of parallel armatures, produce magnetic effects agreeing to within 10 per cent. of the amounts required by the convection theory. A further mode of experimenting is described by M. Vasilesco Karpen, who produces an alternating convection current by rotating an ebonite disc charged by an alternating current.

M. LÉON GUILLET contributes some interesting notes to the *Bulletin* of the French Physical Society on the metallography of nickel steel. The steel was of three different classes, the first having the same structure as carbon steel, the second (mertensite) having the structure of tempered steel, and the third a polyhedral structure. It is found that these classes differ notably in their behaviour when subjected to tempering, heating, extreme cold, and decarburation, and M. Guillet finds a close relation between the mechanical properties of the steel and its micrographic structure.

UNDER the title of *Zeitschrift für wissenschaftliche Photographie, Photophysik und Photochemie*, a new journal has been brought out by Messrs. Ambrosius Barth, of Leipzig. The editors are Dr. E. Englisch (Stuttgart) and Prof. K. Schaum (Marburg), with whom Prof. H. Kayser (Bonn) has cooperated. The first number contains papers on Kirchhoff's laws, by F. Richarz and A. Pflüger; on the photochemistry of silver iodide, by Lüppo-Cramer; and on stereoscopic photography of microscopic objects, by W. Scheffer, the last paper being illustrated by a plate showing stereoscopic representations of a fly and other objects. A noteworthy feature is the collection of abstracts of papers dealing with physical and physiological optics, radiography, photography, and allied subjects, which are to include electricity and wireless telegraphy.

THOSE who are engaged in the teaching of elementary experimental physics will find a mine of wealth in Prof. Bohn's newly-published illustrated catalogue of instruments

and models taken from the Schäffer Museum. The late Hermann Schäffer, whose death was announced in 1900, and who held a chair of mathematics and physics at the University of Jena from 1856 onwards, devoted a large portion of his lifetime to the formation of this collection, which consists of models and instruments constructed for the express purpose of illustrating in the clearest and simplest way the elementary properties of matter, light, heat and electricity. Prof. Bohn describes about 350 apparatus out of a collection of many thousands now housed in the Zeiss Institution in Jena. A noteworthy feature of Schäffer's methods was the great use he made of glass in order that his pupils might see the complete working of the experiments.

WE have received a copy of the second number of a new paper called the *British Inventor*. The new journal contains a few brief notes on scientific novelties, but is chiefly concerned with popular and trade aspects of invention.

WE have received a copy of a catalogue of the Romanised geographical names of Korea, compiled by Prof. B. Kotô and Mr. S. Kanazawa, of the Imperial University of Tôkyô, Japan. The catalogue is published by the Tôkyô University, and should prove of great assistance to travellers in the interior of Korea.

FIVE more parts of the first annual issue of the "International Catalogue of Scientific Literature" have just been published. These newly issued volumes include the second part of vol. iv., which deals with works on physics; vol. x., mathematical and physical geography; vol. xi., mineralogy, including petrology and crystallography; vol. xii., geology; and a volume giving a list of journals with the abbreviations used in the catalogue as references.

THERE has been issued from the Government Printing Office, Washington, U.S.A., a reprint of a "Bibliography of Cooperative Cataloguing and the Printing of Catalogue Cards (1850–1902)," by Messrs. Torstein Jahr and Adam J. Strohm, which was included in the report for 1902 of the Librarian of Congress. In view of the cooperative plans of the Royal Society, the Brussels Institut international de bibliographie, and the Concilium bibliographicum at Zurich for the production of international catalogues of scientific works, the publication of this list of works should interest many European men of science.

PARTS I. AND II. of the *Transactions* of the Royal Society of Edinburgh, dealing with the work of the sessions 1900–1902, have now been published by Messrs. R. Grant and Son, of Edinburgh, and Messrs. Williams and Norgate, of London. Among the twenty contributions to the two volumes, the following may be mentioned as of wide scientific interest: Dr. Masterman's contribution to the life-histories of the cod and whiting; the second part of Sir William Turner's study of the craniology of the people of the Empire of India; Mr. Aitken's notes on the dynamics of cyclones and anticyclones; Mr. Harker's paper on ice-erosion in the Cuillin Hills, Skye; and Dr. Scott's investigation of the primary structure of certain palæozoic stems with the Dadoxylon type of wood. The reports published from time to time in our columns of the meetings of the Royal Society of Edinburgh make any detailed reference to the contents of these volumes unnecessary.

SECOND editions have been issued of Mr. M. M. Pattison Muir's translation of Dr. Robert Lüpke's "Elements of Electro-chemistry Treated Experimentally" (Messrs. H. Grevel and Co.), and of Mr. George Massee's "Text-book of Plant Diseases caused by Cryptogamic Parasites" (Messrs. Duckworth and Co.). Mr. Pattison Muir has incorporated the important changes and additions made by the author in the third German edition, and also added about a dozen new illustrations. Mr. Massee has taken the opportunity to deal in the new edition of his book with several destructive diseases which either have appeared for the first time or have developed and extended to an alarming extent since the appearance of the first issue of his work.

THE fifth edition of the "Introduction to the Study of Metallurgy," by the late Sir William Roberts-Austen, published by Messrs. C. Griffin and Co., Ltd., was fortunately completed by its distinguished author before his death, and has now made its appearance. The book has again been enlarged and improved, and in its present form is necessary to every student of metallurgy who desires to obtain a general view of his subject. Besides being one of the most readable of scientific works, it will provide Sir William Roberts-Austen's many friends with an interesting memento. The two presidential addresses delivered by the author before the members of the Iron and Steel Institute in 1899 and 1900 are printed in an appendix, and the whole volume is a token of the interest he took in the welfare of his students.

THE latest issue of the memoirs of the Société de Physique et d'Histoire Naturelle de Genève contains the president's report for the year 1902, together with a monograph by the late M. Marc Micheli on the Leguminosæ collected in the Mexican States of Michoacan and of Guerrero during 1898 and 1899 by the late M. Eugène Langlassé. The voyage of M. Langlassé had utilitarian ends in view, and his attention was especially directed to plants of interest to the horticulturist, and likely to prove important from the point of view of agriculture, rather than for their scientific interest. Notwithstanding this fact, the number of new species contained in his collection shows conclusively that many new forms will be forthcoming when the country visited by M. Langlassé is systematically explored by competent botanists. Among the 237 kinds of leguminous plants collected, M. Micheli described twenty-six as new species, and he admits one new genus. The monograph is accompanied by twenty-eight beautifully executed plates, which serve as an admirable accompaniment to what proved to be the last piece of work of the author.

IN accordance with a resolution passed at the International Geological Congress at Paris in 1900 to establish a palæontological publication to bring together illustrations and descriptions of type-fossils, an international committee was appointed to prepare a programme of the publication which is to be known as "Palæontologia Universalis." The commission will publish each type-fossil on a separate plate. It has been arranged to reproduce the original figure of the type-fossil, to give a phototypographic figure of the type itself, the original description without alterations or abbreviations, and additional observations by the authors. The two specimen plates which have reached us are excellent, and the series, when complete, should be of great service in making known rare and frequently unknown descriptions and figures of type-fossils. The assistance of numerous palæontologists has been secured, and they will prepare the plates of the type-fossils of the greatest interest in the collections in their care. Dr. von Zittel is president of the committee, and M. D. P. Œhlert is the secretary. The British members are Messrs. F. A. Bather and A. Smith Woodward. The annual subscription is 1*l.* 12*s.*, which should be sent to Messrs. William Wesley and Son, 28 Essex Street, W.C.

THE extraction of the perfume from flowers such as jasmine, tuberose, violet and cassia has long been carried out by the process of enfleurage, the blossoms being left in contact with purified lard for a few days, and then replaced by fresh blossoms. The lard is either sold as such, or the essential oil may be extracted from it by melting it under strong alcohol. As the process of enfleurage is somewhat tedious, attempts have frequently been made to extract the oil directly from the flowers by means of light petroleum, but these processes have not as a rule proved successful, and it has recently been found that a very large proportion of the perfume is actually produced for the first time in the blossoms during the time occupied by the enfleurage. An interesting illustration of this is given by Dr. Albert Hesse in a recent number of the *Berichte*, in which he states that a ton (1000 kilos.) of tuberose blossoms only yielded 66 grams of oil when extracted with light petroleum, but during enfleurage yielded 801 grams of oil to the fat in which they were embedded, whilst a further 78 grams remained in the faded blossoms and could be separated by extraction or distillation. It thus appears that eleven times as much perfume is produced during enfleurage as is originally present in the flowers, and that even after enfleurage the exhausted flowers contain more perfume than when first gathered.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Captain Lambert Larking; a Naked-footed Owlet (*Athene noctua*) from Holland, presented by Mr. R. Souper; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Mr. C. F. McNiven; a Nilotic Trionyx (*Trionyx niloticus*) from West Africa, presented by Mr. Henry Reeve; a Common Chameleon (*Chamoeleon vulgaris*) from North Africa, presented by Mr. M. J. Comyn; three Suricates (*Suricata tetradactyla*) from South Africa, ten Black-spotted Lizards (*Algiroides nigro-punctatus*) from Madeira, deposited; a Thar (*Hemitragus jemlaica*), a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 3. Predicted perihelion passage of Faye's comet.
,, 15h. Mars in conjunction with moon. Mars 1° 49′ N.
8. 12h. 10m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc=0·613, of Mars =0·885.
,, 11h. Uranus in opposition to the Sun.
17. Juno 1° N. of μ Serpentis (mag. 3·6).
,, 14h. Jupiter in conjunction with the moon. Jupiter 3° 7′ S.
19. 11h. 31m. to 14h. 55m. Transit of Jupiter's Sat. IV. (Callisto).
20. 12h. 52m. Transit (egress) of Jupiter's Sat. III. (Ganymede).
22. 3. Sun Enters Gemini. Summer commences.
27 9h. 28m. to 10h. 5m. Moon occults α Cancri (mag. 4·3).
,, 13h. 36m. to 16h. 46m. Transit of Jupiter's Sat. III. (Ganymede).
,, 16h. Mercury at greatest elongation 22° 5′ W.

VARIABILITY OF NOVA GEMINORUM.—A note from Prof. E. C. Pickering which appears in No. 3868 of the *Astronomische Nachrichten* states that the light of Nova Geminorum appears to be fluctuating in a manner similar to that of Nova Persei, No. 2. During the twenty-four hours preceding the evening of May 1, it had increased by half a magnitude.

The nature and amount of these fluctuations will be seen from the following table of measures made at Harvard:—

Date.	Magnitude.	Date.	Magnitude.
April 24	... 9·37	April 29	... 9·61
,, 25	... 9·67	,, 30	... 9·76
,, 27	... 9·71	May 1	... 9·26
,, 28	... 9·81		

ORIGIN OF THE H AND K LINES OF THE SOLAR SPECTRUM.—In a paper communicated to the April number of the *American Journal of Science*, Prof. J. Trowbridge, of Harvard University, gives the results he has obtained from a series of careful experiments which he made in order to determine the constitution of the H and K lines in the solar spectrum, and also discusses the nature of reversed lines in gaseous spectra.

By a series of preliminary experiments he arrived at the conclusion that the lines which he obtained coincident with the calcium lines were not due to any calcium in the glass tubes or the terminals used in obtaining the spark, and further he argues that, even if the glass did contain calcium, the duration of the spark was not sufficiently long to raise the temperature of the glass high enough for it to produce a spectrum, whilst in obtaining his spectra he photographed a part of the spark which was far enough removed from the terminals to ensure the absence of metallic particles ejected by them.

Using quartz tubes sealed by metallic ends he obtained the reversed line at λ 4227, and also lines coincident with the solar lines 3968 and 3933, quite as strong as when a glass tube was used, whilst the other strong calcium lines towards the ultra-violet were conspicuously absent.

Prof. Trowbridge found that the spectra obtained from a highly disruptive spark discharge between electrodes of some metals do not show these lines, whilst those obtained from a similar spark between other metals, *e.g.* pure silver, platinum and iridium, do show them; he suggests that in the former case the metals are easily volatilised, and their vapours conduct the spark, whereas in the case of the latter class of metals the air conducts the discharge because no metallic vapours are produced, and therefore it is some gaseous constituent of the atmosphere which produces the lines in question. For similar reasons he believes that some lines at present attributed to silicon—another highly refractive substance—are possibly atmospheric.

From these observations Prof. Trowbridge arrives at the following conclusions:—"At the basis of the great H.H lines of the solar spectrum there are strong gaseous lines which I believe to be oxygen lines. The reversed lines which apparently coincide with certain calcium lines are not due to calcium but are gaseous." Reproductions of four spectrograms, which accompany the article, illustrate the reasons for these conclusions.

THE LEEDS ASTRONOMICAL SOCIETY.—The tenth annual issue of the *Journal and Transactions* of this Society contains a series of useful papers which were communicated to the Society by its members during 1902. Amongst others there are papers on "Parallax," "Velocities, Paths and Eclipses in the Solar System" (illustrated by diagrams of the various orbits), "The Age of the Earth," "Brightness and Definition," and "The Year's Observations" (which were in the most part observations of Jovian phenomena), all of which should prove of value and interest to amateur astronomers.

The *Journal* concludes with a collection of the papers and letters communicated to other journals by the members of this Society during 1902.

THE ADVANCEMENT OF PHOTOGRAPHY.

AT the recent meeting of the Royal Photographic Society held to celebrate its jubilee, the president, Sir William Abney, K.C.B., F.R.S., suggested, in an address of which an abridgment is given below, that the Society should further mark the close of the first fifty years of its existence by establishing laboratories and suitable accommodation for the carrying out of photographic researches. A donation of 100*l.* has already been promised, on condition that 900*l.* more is raised for this purpose. The establishment of such facilities is highly desirable, for, excluding the work of a few whose names may be counted on the fingers of one

hand, and that done by our manufacturers, which has, so far, succeeded in keeping them in the van of progress, investigations into the underlying facts of photography may be said to be non-existent in this country. A thousand pounds is a very modest sum to ask for, though no doubt it will serve to make a beginning. We hope that before very long this sum will be multiplied many times over, and that the science of photography will begin to take its proper place, instead of being regarded, as it is too often at present, as a very minor detail of a considerable industry, and an empirical art. The following remarks are from Sir William Abney's address:—

Looking back to the first day of this Society's existence, one is forcibly reminded of the advances that have been made, not only in the science, but in the art of photography, but these advances I think might have been more rapid. A very brief comparison of the processes existing now and fifty years ago will show what I mean. Paper processes, founded on the original process of Fox Talbot, were well to the fore fifty years ago, although in 1851 Scott Archer had shown to the world the practicability of taking photographs on glass by means of collodion. In that same year, when the First International Exhibition was held, calotype, Daguerreotype, and collodion processes were all worked commercially, and photographs of the interior of the Palace by all three processes are in being to-day.

At the present time it may be said that for all practical purposes the gelatine process for taking negatives has complete possession of the field, and ousted all processes which have led up to it. Negatives fifty years ago were impressions only given by the violet and blue rays existing in white light, and the resulting prints are such as would be seen by a person colour blind to the red and the green, whilst now it is not uncommon for the photograph to be made to coincide with visual impression of an ordinary eye.

There seems but little doubt that the photographic image remains of the same nature now as it was then, and whatever may have been the action of light then, so it is now, but the necessary exposure to obtain a properly developable image was at least sixty-fold more than is required for our present process, even when the collodion process was employed, where every condition remained the same except the sensitive surfaces themselves. With the Daguerreotype process perhaps we should have required ten times more than for the collodion, though we know of instantaneous work being done even with that process. For open air portraiture, the early Daguerreotypist required half an hour in bright sunshine, whilst the modern amateur will be content with a second or a fraction of a second in the same circumstances. A question one naturally asks is, What causes the difference? So far as I am aware, this question has not been fully answered, and yet it might have been had serious experiment been undertaken regarding it.

From a theoretical standpoint there are three things that have to be taken into account:—1st, the sensitiveness of the silver salt itself; 2nd, the mediums in which it is placed; and 3rd, the means of development. We have some clue to the last two. Beginning with the last first, those who practised Talbotype or the wet collodion processes know that in both of them the developing solution was an acid solution reduced from nitrate of silver, which was on the surface of the plate or paper, to the metallic state, and that there was some attractive force which caused the metallic silver to adhere to and crystallise on particles of sensitive salt which had been acted upon by light. In the gelatine process we know that development is with alkaline solution, and that the image is built up from the very molecules themselves that have been acted upon, the sensitive salt itself being reduced to metallic silver. Why should development be effected more easily in the one case than in the other? In the case of the acid development the distance of the particles of reduced silver from the molecules altered by light are far greater than they are when the material of the plate is attacked, and consequently a smaller attractive force, due to fewer molecules being altered in the latter case, is efficacious in producing a silver image than in the first case where the depositing silver has a considerable distance into which the attractive force has to be exercised. This might be an explanation. Or, again, it may be shown that a gelatine film, being a kind of filter to the developing solution, acts as a regulator in allowing the active alkaline solution to reach the particles of silver salt, and that this regulated supply would attack the molecules on which light had done part of the work of decomposition, and reached the remaining part most readily to be finished and so on, and that very little external retarding influence was necessary. But now, what is to be said regarding the increased instability of the sensitive salt? This is a question not yet investigated, but it is from such an investigation that increased rapidity is to be looked for.

But it is one thing to say what proof is required, and it is another to have the opportunity of making such proofs, and I should urge that it is part of the duty and functions of the Royal Photographic Society to lead the way in placing such means at the disposal of its members and others as will enable any of them who have the capacity to experiment in this and in any other directions which will lead to a theoretical knowledge of the action of light. It must not be forgotten that there are a great many more men with minds trained to scientific research now than formerly. There are plenty of would-be capable workers who cannot afford a laboratory of their own, and what I should wish to see in this our jubilee year is the commencement of the formation of a research laboratory adapted to the needs of the scientific workers.

One branch of photographic science is the optical, and in it we have an example of what laboratory and experimental research can do when workers are trained in scientific methods. Not many years ago the optician was challenged to increase rapidity of exposure by increased rapidity of lens. Nobly and rapidly he has responded; the advent of Jena glass enabled him to comply with the demand, and we have been getting definition of image with ratio of aperture to focal length which would have been deemed impossible not very many years ago.

I do not believe a laboratory would be an expensive matter to start. What I do advocate is to have all essentials of all instruments of first-class workmanship, and to leave the adaptation of any instrument from one special work to that of another to the worker. Hence, if my views are carried out, the initial expenses will not be so great as might be supposed. Space is the foundation of all research in photography, and that is what the Royal Photographic Society can supply, and then comes the provision of the apparatus necessary to use in such space.

I have heard that one generous man will give 100*l.* to the laboratory if 900*l.* more are raised. The 1000*l.* would go a very long way towards what we want to start with, and I hope the members of the Society will resolve to give substantial help in raising this 900*l.* The jubilee of the Society should be marked by some important piece of work, and no bigger one and more requisite is, to my mind, to be found than starting such a help to the advancement of photography.

RADIO-ACTIVE GAS FROM TAP-WATER.[1]

WHEN Cambridge tap-water is boiled the air given off is mixed with a radio-active gas. The existence of this gas is easily demonstrated by electrical means, for if the air expelled by prolonged boiling from about 10 litres of water is introduced into a closed vessel the volume of which is about 600 c.c., the amount of ionisation in the vessel (as measured by the saturation current) is increased five or six times. When the water has once been well boiled the gas expelled on any subsequent re-boiling is not appreciably radio-active. The gas can also be extracted from water at the temperature of the room by vigorously bubbling air through it; the air as it bubbles through the water gets mixed with the radio-active gas and carries it along with it. When water which has been treated in this way is boiled, no radio-active gas is given out, nor is the gas given off when air is bubbled through water which has been well boiled.

The gas extracted in this way from the water retains its

[1] Paper read before the Cambridge Philosophical Society on May 4 by Prof. Thomson, F.R.S.

radio-active properties after bubbling through strong sulphuric acid, or caustic potash after passing over red-hot copper, or through a narrow platinum tube kept at a white heat; it does not seem appreciably affected when sparks are passed through it.

The gas can diffuse through a porous plate, and by comparing its rate of diffusion with that of CO_2 through the same plate, its density can be determined by Graham's law; preliminary measurements of this kind indicate that two different gases are present, of which one has a density about twice, the other between six and seven times that of CO_2. The gas obtained by boiling the water always diffused faster than that procured by bubbling air through the water; it seems possible that in the latter case the gas may get loaded with water-vapour to a greater extent than in the former.

A negatively electrified surface exposed to the gas becomes radio-active, the induced radio-activity dying away to half its value in about forty-five minutes. Mr. Adams has shown that a positively electrified surface also becomes radio-active when exposed to the gas, though to a smaller extent than if it had been negatively electrified; an unelectrified surface does not become radio-active. In this respect the gas differs from the emanation from radium, which, according to Rutherford, produces much more induced radio-activity in an unelectrified surface than in a positively electrified one.

The rate of diffusion through a porous plate of the gas obtained by bubbling air through distilled water containing a trace of radium is not the same as that of the gas got by bubbling through tap-water.

If the gas is confined in a closed space its radio-activity slowly diminishes. Mr. Adams found that the gas contained in a vessel of about 300 c.c. capacity lost when not exposed to an electric field about 5 per cent. of its activity in twenty-four hours; under a strong electric field the rate of loss was doubled. Water drawn from the tap and left exposed in a bucket for a fortnight gave off very little of the gas when subsequently boiled. I have not found any of the gas in any of the numerous samples of rain and surface water which I have tested.

Prof. Dewar (to whom I am greatly indebted for assistance and advice) was kind enough to subject the gas obtained by boiling the water to treatment by liquid air. Two samples were treated: one, containing about 80 litres of gas, obtained from the coppers of the Star Brewery, Cambridge, by the kindness of Mr. Armstrong (to whom I wish to express my thanks), was passed slowly through a bath of liquid air, and samples of the emergent gas collected; this on testing was found to have no radio-activity, though it was strongly radio-active before passing through the liquid air; it is evident, therefore, that at the temperature of liquid air the radio-active gas is frozen out. The other sample, of 20 litres, prepared in the laboratory was actually liquefied; the liquid was then allowed to boil away, the gas coming off at the commencement of boiling was collected, and also that coming off when the liquid had all but boiled away. On testing the samples for radio-activity the former was found to be slightly radio-active, but not nearly so much so as before liquefaction, while the second was extraordinarily radio-active, its activity being quite thirty times that of the original gas, thus showing, as we should expect from its great density, that the radio-active gas is much more easily liquefied than air.

The liquid obtained in the preceding experiment had a very strong smell of coal-gas. I must again express my thanks to Prof. Dewar and Mr. Lennox for their kindness in making these experiments.

A discharge tube was filled with strongly radio-active gas obtained as above, and the spectrum was most kindly investigated by Mr. Newall, who photographed it and measured the lines; no new lines were, however, discovered, the lines present being mainly those due to hydrocarbons.

I add a list of the various specimens of water I have examined; yes, means that the water contains the gas; no, that it does not.

Cambridge tap-water (yes). Rain water (no). Water from ditch round Botanical Garden (no). Water from Trinity College well, on the Madingley Road (yes). Water from artesian well in Mr. Whetham's garden, Chaucer Road (yes). Water from shallow well in same garden (no). Water from well at Star Brewery (yes). Artesian well in Trinity Hall Cricket Ground (yes). Artesian well at Girton (yes). Ely Town's water (yes). Birmingham Town's water (yes). Ipswich Town's water (yes).

In concluding this preliminary account I have much pleasure in thanking my assistant, Mr. E. Everett, for his help in this investigation.

GEOGRAPHICAL RESEARCH.

IN the course of his presidential address at the recent anniversary meeting of the Royal Geographical Society Sir Clements Markham, K.C.B., F.R.S., outlined a scheme, which is shortly to be put in operation by the Society, for the purpose of encouraging geographical research. The plan to be tried is the outcome of the afternoon meetings of the Society, started in 1894, for the reading and discussion of strictly scientific or technical papers. It is hoped that by the plan outlined in the subjoined extract from the president's address, the value of the afternoon meetings will be increased, and the scientific side of geography will be developed.

A permanent committee has been appointed to deal with this department of the work of the Society, to be called the "Research Committee." It will consist of those Fellows, taken from the List of Referees (which includes Fellows who have read papers, published books, or are known to have a special knowledge of any department of geography), who are most interested in, and best qualified to deal with, the subjects which are embraced in geographical research, as distinguished from exploration, in all its numerous branches. The committee will meet for the discussion of such results of investigation as may be brought before it; and the Council may be able to set apart a moderate sum each year for the purpose of encouraging such researches among the younger geographical aspirants.

Among the numerous lines that research may take, the following have been suggested:—

New methods of surveying, mapping, or computing.

Discussion of a definite problem of geomorphology (*e.g.* analysis of a river system or a coast-line).

Discussion of a definite problem of hydrography (*e.g.* circulation of water in a restricted sea area).

Discussion of a definite problem of meteorology (*e.g.* modifications of general weather conditions by local features).

Regional studies (*e.g.* synthesis of the geography of a county or of a natural unit such as the Fens).

Investigation of distribution (*e.g.* of some crop in relation to natural facilities and access to markets; of former forests in relation to existing boundaries; of village and town sites in a district).

Mapping of distribution of plant associations in a given area, or of a human disease in relation to climate and soil.

History of the map of some country (*e.g.* the British Isles).

Investigation of evidence of physical changes within historical times (*e.g.* the British coasts; the desiccation of continents).

Discussion of the relation of land forms to military movements in a selected area, or a chosen campaign.

Discussion of the relation of land forms to the distribution of man; to the distribution of animals in any area.

Geographical conditions affecting the development and colonisation of any given region.

Complete investigations from the geographical standpoint of a limited area of unexplored or partially explored territory.

There is still ample room for exploration and expeditions of discovery. We have scarcely yet laid down the great lines of the world's geography, and there is work for generations to come in filling in the details, though future exploration must become more and more exact and scientific in its characters. But we ought also to encourage research, for which exploration furnishes the raw material. By the plan now in contemplation, we shall develop the purposes of the List of Referees by constituting the Research Committee; and we shall develop further the object of the afternoon meetings by promoting research, the results of which will place the meetings on a more assured and regular system, by creating the necessity for their being more frequent and at fixed intervals.

NATURAL HISTORY NOTES.

WE learn from a contemporary that Mrs. Anderson has recently presented to the British Museum the whole of the zoological collections of her late husband, Dr. John Anderson. The great value of this collection is that it comprises all the original specimens on which Dr. Anderson based his great work on the mammals of Egypt. It also includes a collection made by Mr. T. Bent in the Hadramaut district of Arabia, and many specimens procured by Mr. H. F. Witherby in the Eastern Sudan—areas of which the fauna was but imperfectly represented in the Museum.

Visitors to the Natural History Museum will not fail to notice the fine new pair of giraffes from East Central Africa which have just been placed on the top of the flight of steps to the right of the Darwin statue. They replace a battered specimen which has been on exhibition since 1842. The male is presented by Mr. Rothschild and the female by Captain Powell-Cotton; both are mounted by Rowland Ward.

Bad Latin, as exemplified in scientific names, is, according to Prof. Cockerell (*Popular Science Monthly* for December, 1902), an evidence of too much narrowness and too little general culture among American naturalists. As regards the amount of zoological work done by the latter, it has been estimated that this should be about one-seventh of that of the whole world, and judging from the "Zoological Record," this estimate appears to be somewhat exceeded by the reality. This, however, according to the author, represents only a fraction of the work awaiting to be done if only the number of labourers were sufficient. "The Making of Biologists" forms the title of another article by the same author in the April number of the aforesaid serial, in which it is urged that, although naturalists are undoubtedly "born" rather than "made," yet that many are deterred by adverse circumstances from embarking on the career most suited to their abilities.

An English translation, by Mr. W. H. Clifford, of two memorials presented respectively in 1895 and 1896 to the Governor and Legislature of Para by Dr. H. Goeldi, directing attention to the destruction of white herons (egrets) and scarlet ibises on the Lower Amazon, has been recently published at Para. Whether protective legislation has been the result of these appeals is not stated, but from the details of the slaughter it is quite evident that such protection is urgently needed. In an appendix the author directs attention to the possibilities of egret-farming, and states that this has been established with successful results in Tunis. Egret-plumes are worth more than their weight in gold, and the profits from a "farm" of this nature, where the feathers are cut from the birds at the proper season, ought to be very large.

In the May number of *The Field Naturalists' Quarterly* the editor directs attention to the great increase in the membership of field clubs and societies, and the multiplication of such institutions all over the country, as satisfactory proof of the awakening of interest in natural history. Among the articles in this number are one, by the Rev. G. C. Bateman, on newts in spring, and a second, by Mr. J. R. B. Masefield, on the white cattle of Chartley, Staffordshire, both illustrated. In the latter the author adopts the view that British white park cattle are the descendants of white sacrificial cattle introduced by the Romans, ignoring the close relationship between the Chillingham herd and the old Pembroke breed so strongly insisted on in Low's "British Domesticated Animals." Apparently he has not visited the domesticated series in the Natural History Museum, or, at all events, has not read the descriptive labels.

Unusual interest attaches to an article by Prof. G. H. Parker on the hearing of fishes in the March number of the *American Naturalist*. After mentioning that the sense of hearing is restricted to a small number of animal groups—notably insects and vertebrates—and is consequently a special development, the author refers to recent investigations which have been thought to prove that the ear of fishes is not connected with the auditory function. This view he believes to be incorrect, and he is convinced that fishes do hear sound-waves communicated through water. The intimate connection between sound and touch is strongly insisted upon, and it is shown that fishes—and, to a certain extent, amphibians—exhibit in a marked degree the connection between the tactile and auditory senses by means of the lateral line system. The three sets of sense-organs under consideration—namely, the skin, the lateral line, and the ear—"may be regarded as having slightly different kinds of stimuli; the skin being affected by surface-waves and currents; the lateral line organs by slight inaudible movements of the whole mass of water; and the ears by the still more delicate vibrations of water particles, sound. . . . Hearing, then, is a most delicate form of touching, and the organ of hearing has developed late in the animal series because its processes are not original, but are derived from those of the more primitive sense, touch."

Indian Museum Notes, as exemplified by vol. v. No. 3, maintains its high reputation as a chronicle of the economic entomology of the Indian Empire, this part containing five original communications from writers who are not members of the museum staff, and an important series of notes by the latter. In the first category Mr. E. P. Stebbing discusses the insect pests of the sugar-cane, while among the second reference may be made to investigations which have been undertaken in connection with insects found in drinking water. It appears that in December, 1900, the filtering beds of the Calcutta water-supply were swarming with a dipterous larva, which on examination proved to belong to the midge *Chironomus cubiculorum*, while in the following year the lake in the city of Colombo, Ceylon, was found to be so infested with the larva of a member of the same genus as to be dangerous to health. Special means for exterminating this "lake-fly" are suggested by the Government entomologist.

We learn from the April number of its official organ, the *Emu*, that the Australian Ornithologists' Union has successfully completed the first year of its existence, and that its work is steadily progressing. The excellence of its journal speaks for itself, and it may be regarded as a proof of its success that the present part contains a beautiful coloured plate, by H. Gronvöld, of blue wrens (Malurus). Perhaps the most noteworthy feature of the work of the Australian O. U. relates to the protection of indigenous birds, and the prevention of the trade in so-called "osprey" plumes. It is most satisfactory to learn that action has been taken for the better protection of the colonies of egrets in Victoria, which were so ruthlessly attacked for the sake of their plumes, with the result that the Government has decided to protect them throughout the year. Suggestions have been forwarded to the Government of Queensland with regard to the advisability of reserving certain islands for the peculiar Torres Strait or nutmeg pigeon, and efforts have been made to secure one of the Victorian lakes as a breeding-reserve for wild-fowl. The Tasmanian Government has also been approached with a view of preventing the wholesale destruction of the eggs of the Cape Barren geese breeding in certain islands of Bass Strait, since it is feared that the species is in danger of extermination. Action has likewise been taken to ensure the protection of the colonies of petrels, or "mutton-birds," breeding on Phillip Island.

"Os Mosquitos no Pará" forms the title of a pamphlet by Dr. E. Goeldi, recently issued by the Government Press of Para.

To the *Journal* of the Asiatic Society of Bengal (vol. lxxi. No. 2) Mr. K. B. Sanyal contributes some observations on the habits of the orang-utan in captivity.

We have received the report of the Rugby School Natural History Society for 1902, which contains a prize essay on the Tertiary rocks of Hampshire, by Mr. H. A. Ormerod, and shows that the Society continues to prosper.

In the *Boletin* of the Agricultural Commission on Parasites of Mexico (vol. i. No. 8), Prof. T. D. A. Cockerell describes a new scale-insect (*Neolecanium herrerae*) infesting agave; while in the February number of *Psyche* the same writer records several new races of various species of the same group belonging to the genus Eulecanium.

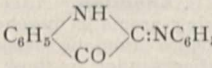
The *Boletim* of the Para Museum contains, among other papers, a list of the birds of Amazonia, extracted from the British Museum Catalogue, and a descriptive synopsis of the lizards of Brazil, both by Dr. E. Goeldi. Botanists will be interested in a paper on the "rubber-trees" of Amazonia, by Dr. J. Huber, as well as in a fifth instalment of the same author's account of the Amazonian flora.

A NEW SYNTHESIS OF INDIGO.

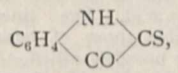
AN important new synthesis of indigo is described by Dr. T. Sandmeyer in the April number of the *Zeitschrift für Farben- und Textil-Chemie*. The starting point for the synthesis is thiocarbanilid, $CS(NH.C_6H_5)_2$, which is converted in one operation by the simultaneous action of white lead and potassium cyanide into the hydrocyanide, $C_6H_5.N:C(CN).NH.C_6H_5$, of carbodiphenylimide. This compound is changed by the action of yellow ammonium sulphide into the thioamide,

$$C_6H_5.N:C(CS.NH_2).NH.C_6H_5,$$

which, when stirred into warm sulphuric acid, undergoes condensation, and yields an α-isatinanilide,



The anilide is converted directly into indigo when dissolved in alcohol and reduced with ammonium sulphide, but the indigo separates in glistening crystals which cannot easily be reduced by the ordinary methods, and so is unsuitable for commercial use. A better method, and one which renders it unnecessary to separate the isatinanilide from the sulphuric acid used in its preparation, consists in allowing the acid solution to flow into ice-water simultaneously with a solution of sodium sulphide, when the anilide is converted into thioisatin,



which is thrown down as a bulky precipitate. In order to prepare the indigo it is now only necessary to make the precipitate into a thin paste and mix it with a little alkali, when the thioisatin rapidly decomposes into indigo and sulphur. The sulphur is removed by extracting with carbon disulphide, and the indigo is left in the form of light, dark-blue blocks, which readily crumble when rubbed between the fingers, and can be made into a uniform paste which is easily reduced to indigo-white. The patents are held and are being worked by J. R. Geigny, of Basle, and the process may prove to be a formidable rival not only to natural indigo, but also to the synthetical process employed by the Badische Anilin- und Soda-Fabrik.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 249th meeting of the Junior Scientific Club was held on May 20. Mr. H. S. Souttar gave an exhibit of an automatic method of drawing capillary tubes intended for use in the capillary electrometer. Mr. S. A. Ionides read a paper on "Mining in Cornwall," in which he gave an account of the methods employed for raising and washing the tin ores.

CAMBRIDGE.—Mr. Andrew Graham, who has for nearly forty years held the office of chief assistant at the observatory, and is known to astronomers as the discoverer of *Metis*, is retiring at the age of eighty-eight. It is proposed to assign him a pension of 200*l*. a year.

The use of the Senate House has been granted to the local committee of the British Association for the meeting to be held in Cambridge next year.

LORD KELVIN and Lord Lister are to receive the honorary degrees of doctor of science from the University of Wales next November.

MR. W. M. CHILDS, vice-principal of University College, Reading, has been elected principal of the College in succession to Mr. H. J. Mackinder, who resigns office in September next.

IT is stated by the *Electrician* that a donation of nearly 40,000*l*. has been promised by Lord Iveagh to Trinity College, Dublin, with the object of building and equipping scientific laboratories.

THE Liverpool University Bill was, on Tuesday, reported for third reading by Lord Morley, Chairman of Committees of the House of Lords. The object of the Bill is to separate University College, Liverpool, from the Victoria University, and to merge it into the University of Liverpool.

THE annual report of the Royal Agricultural Society, which was adopted at the general meeting held on May 22, states that with the view of bringing before the public the general characteristics of the teaching now provided at agricultural colleges, and of directing attention to the Society's own share in this work as a national examining body, the council has decided to organise an agricultural education exhibition as a new feature of its annual show.

IN his recent paper read at a meeting of the Society of Arts Mr. G. T. Morrison gave a clear and useful account of the modern methods of construction of maps and charts. His descriptions of orthographic, stereographic, Mercator's, gnomonic and elliptical projections should prove of great assistance to teachers who wish to explain the methods employed to make maps, which either give good general ideas of the appearance of the whole or of parts of the earth, or retain some one property of the sphere at the expense of disregarding the others. Mr. Morrison thinks that for the purpose of teaching geography a projection based, not on any distinct mathematical rule, but on a system of compromise, is on the whole the best—one, for example, on which the meridians and parallels are spaced at equal distances throughout.

ARRANGEMENTS have been made for an allied colonial universities dinner and conference to be held early in July. The conference will be held on July 9 at the rooms of the Royal Society, Burlington House (by permission of the president), to discuss the question of the coordination of university education throughout the King's dominions, and the development of post-graduate courses in applied science. It is expected that an Imperial council will be formed to deal permanently with these interests. The dinner will be held on Friday, July 10, at the Hotel Cecil. The Lord Chancellor and other statesmen, many high public officials, representatives of colleges and universities in the United Kingdom and the colonies, and several distinguished men of science are expected to be present. Graduates and undergraduates of colonial universities wishing to attend the dinner, or to take part in the conference, are requested to write as soon as possible to Mr. C. Kinloch Cooke, hon. sec., 3 Mount Street, London, W.

THE annual catalogue, 1902–3, of the Massachusetts Institute of Technology at Boston gives very full particulars of the numerous courses of instruction in connection with the institute, a clear plan of the extensive buildings, a register of graduates, and other interesting details. The tuition fee for regular students is 50*l*. per annum, for half a year or any shorter period the fee is 30*l*. Special students pay, in general, the full fee; but when a few branches only are pursued and the time required for instruction is limited, applications for a reduction in the fees are considered. Regular students whose financial necessities are such as to prevent their continuance at the institute are encouraged to apply for aid to the scholarship committee of the faculty. Students may conveniently live in any of the nearer cities or towns, since the hours of the institute are from 9 to 5. The cost of board and rooms in Boston and the neighbouring towns need not exceed from thirty shillings to two pounds a week. The cost of books and material varies from five to seven pounds a year.

THE second clause of the London Education Bill, referring to the constitution of the education committee was withdrawn by the Government on Monday. In its original form the Bill provided for the appointment of thirty-one representatives of the borough councils upon the committee. This number was reduced to twelve in Committee of the House of Commons last week, but the compromise pleased nobody, so the whole clause, with its restrictions upon the local authority with regard to the constitution of the Education Committee, has been omitted from the Bill. By this action the London County Council, so far as the constitution of its education committee is concerned, is placed in precisely the same position as other local authorities brought into being by the Act of last year. The Council will frame a scheme for itself, just as other county councils have done, or are doing, and under the same conditions.

On Tuesday the Bill passed through Committee, but the third clause was greatly modified. In its altered form the clause provides for a body or bodies of management in each borough, constituted so as to include one-fourth members nominated by the County Council, and three-fourths by the borough council. The measure, as passed, does not include the clause giving the borough councils the power of appointing and dismissing teachers.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, vol. iv. No. 2 (April).—G. H. Darwin, approximate determination of the form of Maclaurin's spheroid.—H. S. White, on twisted cubics that have a directrix.—L. Heffter, line-integrals in *n*-dimensional space.—E. Kasner, the generalised Beltrami problem concerning geodesic representation.—G. A. Miller, on the holomorph of a cyclic group.—J. L. Coolidge, quadric surfaces in hyperbolic space.—A. Loewy, on the reducibility of real groups of linear homogeneous substitutions.—W. B. Ford, on the possibility of differentiating term by term the developments of an arbitrary function of one real variable in terms of Bessel functions.—E. J. Wilczynski, on a certain congruence associated with a given ruled surface.—J. Westlund, on the class-number of the cyclotomic field $k(e^{2\pi i/p^n})$.

Bulletin of the American Mathematical Society (2) vol. ix. No. 8 (May).—E. H. Moore, presidential address on the foundations of mathematics.—C. J. Keyser, concerning the axiom of infinity and mathematical induction.—E. R. Hedrick, review of R. Fricke's treatise on the differential and integral calculus.

SOCIETIES AND ACADEMIES.

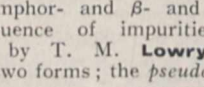
LONDON.

Royal Society, May 7.—"Experiments in Hybridisation, with Special Reference to the Effect of Conditions on Dominance." By L. **Doncaster**, B.A., King's College, Cambridge. Communicated by Dr. S. F. Harmer, F.R.S.

Describes experiments on hybrid Echinoid larvæ, made to determine whether the dominance of a character is influenced by the condition of the genital cells at the time of fertilisation. It is concluded that there is no evidence that this is the case, and that the seasonal changes observed in the larvæ are due to difference in temperature.

May 14.—"A New Class of Organo-Tin Compounds containing Halogens." By William J. **Pope**, F.R.S., Professor of Chemistry, Municipal School, Manchester, and Stanley J. **Peachey**.

Chemical Society, May 7.—Prof. H. McLeod, F.R.S., vice-president, in the chair.—It was announced that the council at its meeting that day had awarded the Longstaff medal to Prof. W. J. **Pope**, F.R.S., for his researches on the stereochemistry of compounds of elements other than carbon.—The following papers were read:—The action of ammonia and organic bases on ethyl esters of olefine-dicarboxylic and olefine-β-ketocarboxylic acids, part ii., by S. **Ruhemann**.—Spontaneous decomposition of nitrocamphor, by T. M. **Lowry**. A quantity of nitrocamphor, prepared in 1898 and purified by recrystallising once from alcohol, was found to have undergone spontaneous change into a sesquicamphorylhydroxylamine, identical with that prepared from camphoryl chloride and camphoryloxime.—β-Bromo-α′-nitrocamphor- and β- and π-bromocamphoryl-oximes. The influence of impurities in conditioning isomeric change, by T. M. **Lowry**. β-Bromo-α′-nitrocamphor exists in two forms; the *pseudo*-form,



separates from solutions of the nitro-compound in benzene or ethyl acetate. The normal form was not isolated. A mixture of the two forms, obtained by crystallising from hot alcohol or acetic acid, softened at 100°, melted without decomposition at about 114°, and remelted sharply at 100°; the latter is therefore the temperature at which the solid *pseudo*-form is in stable equilibrium with the liquid mixture. Freshly prepared solutions of β-bromo-α′-nitrocamphor exhibit the phenomenon of mutarotation. A solution in benzene of the *pseudo*-form is at first almost inactive, but in the course of two or three days the specific rotatory power becomes constant and equal to −80°. The change of rotatory power is not spontaneous, but is conditioned by the presence of traces of impurity. This fact shows that, even when both isomerides are present in solution, equilibrium between them is only established in presence of a trace of a catalytic agent, probably an alkali. These phenomena are closely analogous to Baker's observations on the union of hydrogen and oxygen, and are directly opposed to Laar's hypothesis of "tautomerism."—The electrolytic reduction of pheno- and naphtho-morpholones, by F. H. **Lees** and F. **Shedden**. Attempts were made by electrolytically reducing aromatic morpholones in sulphuric acid solution to produce aromatic morpholines possessing physiological properties similar to those of morphine; the morpholone ring, however, usually undergoes secondary decomposition.—The coloured constituents of *Butea frondosa*, by E. G. **Hill**. The dried and fresh flowers of *Butea frondosa*, used in India for the preparation of a somewhat fugitive yellow dye, contain fisetin and different anhydrides of a tannic acid.—Butein. A preliminary notice by (the late) J. J. **Hummel** and A. G. **Perkin**. Butein, the colouring matter of the flowers of *B. frondosa*, described by Hummel and Cavallo in 1894, probably exists in two modifications which, on fusion with alkali, give resorcinol and protocatechuic acid. The tinctorial properties of butein closely resemble those of benzylideneanhydroglycogallol, to which it is possibly allied.—The relative affinities of polybasic acids, by H. M. **Dawson**.—The chemical dynamics of the reactions between chlorine and benzene under the influence of different catalytic agents and of light, by A. **Slator**. With a large excess of the hydrocarbon, the relative amounts formed of the two chief products chlorobenzene and benzene hexachloride depend on the conditions of the experiment. The velocity of these reactions, especially under the influence of different catalytic agents, has been measured under various conditions. Under the influence of light without catalysts, the addition reaction alone occurs; under conditions of equal illumination, the velocity of this change is found to be proportional to the square of the chlorine concentration.—The diazo-reaction in the diphenyl series. Part i. On dianisidine and 3 : 3′-dichlorobenzidine, by J. C. **Cain**. On heating aqueous solutions of the diazonium salts prepared from dianisidine and 3 : 3′-dichlorobenzidine, dark-coloured, insoluble, infusible compounds which appear to be quinones are obtained instead of the expected dihydroxy-derivatives.

Linnean Society, April 16.—Rev. T. R. R. Stebbing, vice-president, in the chair.—Dr. G. **Henderson** exhibited a coloured sketch of a withered leaf of *Quercus incana*, Roxb., and of slugs found amongst the dead leaves. The drawing of the mollusc and leaf was to show their strange resemblance in colour and outline. These slugs are common at Dalhousie in the Punjab, on ground which is always covered with these withered leaves. A few black slugs were to be found with the light-brown specimens, and whilst the latter escaped the notice of birds, the former were taken.—On some points in connection with the ordinary development of Vaucheria resting-spores, by Dr. H. C. **Bastian**, F.R.S. In 1891 the author had some spores of Vaucheria under observation in a bottle loosely covered with a screw-cap, and after a few weeks these spores were found to be germinating and emitting filaments. In 1902 the experiments were repeated on *Vaucheria racemosa*; material was kept in a shallow dish, and a few days later the spores were transferred to a stoppered bottle; another portion was put into a tumbler, loosely covered to exclude dust. Within seven weeks the bottled specimens germinated, a process which did not take place in those in the tumbler for some time later. Special attention was drawn to the pigment-granules, to be regarded as refuse-products left over during the molecular transformation that the spore has undergone in becoming decolorised; they are heaps of fine granules, without any bounding membrane. These pigment-heaps pass into the filament as spheres with a sharply-defined outline, or else press together in compressed forms. Slight to-and-fro movements were detected in them. One pigment sphere

was seen to be encysted, outside the filament from which it had been liberated. These forms resemble Amœbæ or the simplest form of Actinophrys, but seem to be so heavily charged with indigestible matter as to have but a slender chance of further development.—On the labial and maxillary palpi in Diptera, by Mr. **Wesché.** The author set out to homologise the mouth-parts of Diptera with the typical insect mouth-part, and stated that in the Muscidæ the mandibles are embedded in the dorsal side of the labium. The maxillary palpi, galæ, and laciniæ are aborted, but the cardines and stipes remain; the latter parts bear minute rudiments of the maxillary palpi. The palpi present are labial. In the Syrphidæ and Empidæ the mandibles are similarly placed, but the maxillæ are represented by the laciniæ, the *palpi*, cardines, stipes, and palpifers. The labial palpi are aborted. The author formulated a rule, that *the maxillary palpi when present in Diptera are always in contact with the upper part of the cardines, the stipites.*—Observations on fresh-water rhizopods, with some remarks on their classification, by Prof. G. S. **West.** The author states that whilst examining material from the western districts of the British Islands, interesting rhizopods came under notice, concerning four of which he could find no previous mention. Two of these are species of Hyalosphenia, one is a species of Sphenoderia with a prettily constructed shell, and another is a curious nude form referable to Cienkowski's genus Nuclearia. With regard to the distribution of rhizopods in the west of Scotland, the noticeable feature is the relative scarcity of these animals in the Outer Hebrides as compared with their occurrence on the Scottish mainland. Full reasons are given for the establishment of the Vampyrellidæ as a distinct order of fresh-water rhizopods, to include the genera Vampyrella and Nuclearia.

PARIS.

Academy of Sciences, May 11.—M. Albert Gaudry in the chair.—New studies on a law relating to the electromotive forces developed by the reciprocal action of saline solutions, by M. **Berthelot.** If E is the E.M.F. developed by the action of an acid on a base, and the E.M.F. developed by the action of the corresponding salt on the acid be ϵ_1 and on the base ϵ_2, then the author has established experimentally the law $E = \epsilon_1 + \epsilon_2$.—On the traces of the Lutitian sea in the Soudan, by M. **de Lapparent.** Fossils found by French officers in the Soudan, including a new species of Plesiolampas, undoubtedly belong to the Middle Eocene. It may thus be considered as certain that the Lutitian sea, traces of which have been already made out with certainty in the neighbourhood of Dakar, spread out into the heart of the Soudan.—On the existence of radiations capable of passing through wood and certain metals in the rays from an incandescent mantle, by M. R. **Blondlot.** The radiations were detected by their action on very small sparks, the arrangement of the apparatus being similar to that previously described by the author in connection with the radiation of an X-ray focus tube, and also by their photographic action. They resemble in some respects the rays of long wave-length discovered by Rubens, in that both are emitted by an incandescent mantle, and are stopped by water. On the other hand, the Rubens rays are stopped by metals, which are traversed in thin layers by the radiations now described.—On a class of differential equations reducible to Bessel's equation, by M. Alexander S. **Chessin.**—On the zeros of monodrome functions, or with ν branches, by M. Edmond **Maillet.**—On thermomagnetic effects in bismuth-lead alloys, by M. Edmond **van Aubel.**—On the modulus of traction and the coefficient of expansion of vulcanised indiarubber, by MM. **Bouasse** and **Carrière.** In reasoning from the equation $dL = \alpha.dt + \epsilon dP$, dL is usually taken as an exact differential. This, however, is far from being the case; the coefficients α and ϵ are very variable, since they depend upon the previous history of the specimen under examination. It is shown that the value of these coefficients may be made to vary between wide limits by varving the cycle of operations, and it is not possible on theoretical grounds to give the preference to any one of these.—On the electrolysis of alkaline sulphides, by MM. André **Brochet** and Georges **Ranson.** It has been shown in previous work that the final product of electrolysis is sulphate, with an intermediate formation of thiosulphate. Working in concentrated solution at 50° to 70°, the process is entirely different, sulphur being deposited at the anode and sodium at the kathode, hydrogen and sodium hydroxide appearing in the latter case as the secondary products. The sulphur formed dissolves in the sulphide, giving polysulphides.—On benzeneazo-orthobenzyl alcohol and on its transformation into phenylindazol and azodiphenylmethane, by M. P. **Freundler.** The alcohol is easily obtained by the condensation of nitrosobenzene with *o*-aminobenzyl alcohol in presence of alcohol and acetic acid.—Organometallic derivatives of aromatic hydrocarbons containing two halogen atoms in the nucleus, and their interaction with iodine, by M. F. **Bodroux.** The dihalogen derivative reacts with magnesium to give $X.C_6H_4MgX$, and this, with iodine, forms the mixed halogen compound $C_6H_4.XI$. The reaction appears to be general, and has been extended to naphthalene compounds.—On the methylation of ethyl glutaconate, by M. E. E. **Blaise.**—The migration of the methyl group in the camphor molecule, by MM. G. **Blanc** and M. **Desfontaines.**—On the successive action of acids and soluble ferments on polysaccharides of high molecular weight, by MM. Em. **Bourquelot** and H. **Hérissey.**—The diastatic hydrolysis of salol, by M. Emm. **Pozzi-Escot.** The hydrolysing ferments of plant seeds, which act easily upon the esters of the fatty acids, are nearly without action upon the phenol ethers.—On the law of electrical excitation in some invertebrates, by M. and Mme. L. **Lapicque.** It is shown that the law enunciated by Weiss is only an approximate one; the establishment of a more correct formula is reserved for a later communication.—Excretion and phagocytosis in Onychophores, by M. L. **Bruntz.**—On the absorption of the tetanic antitoxin; the immunising action of dry antitetanic serum, by M. A. **Calmette.**—On the reversibility of lipolytic actions, by M. Henri **Pottevin.** If oleic acid be added to a glycerol extract of the pancreas, partial esterification takes place; starting with mono-olein, a partial hydrolysis occurs, and in both cases there is a final state of equilibrium produced, characterised by the same value for the ratio between the weights of the free and combined acid.—The influence of formaldehyde on the growth of white mustard, by MM. **Bouilhac** and **Giustiniani.** When, owing to insufficient light, the chlorophyll assimilation of the plant is rendered difficult, formaldehyde may serve as a plant food, but if the intensity of the light is diminished below a certain amount, this assimilation ceases, the formaldehyde exerts a poisonous effect, and all the plants die.—How far is it possible to modify the habits of plants by grafting? by M. Lucien **Daniel.**—On the spontaneous combustion of balloons, by M. W. **de Fonvielle.** Certain explosions of balloons would appear to be traceable to electrical effects, which determine a spark at the moment the aëronaut grasps the valve rope. As a precaution, the use of indiarubber gloves is suggested in stormy weather.—On the culture of the truffle, by M. Émile **Boulanger.**

May 18.—M. Albert Gaudry in the chair.—The statistics of the minor planets. The distribution of the elements, taking the aphelion longitude as argument. The comparison of the minor planets with short period comets, by M. O. **Callandreau.**—The measurement of the velocity of ships at sea, by M. E. **Guyou.** A return to the oldest form of line log is suggested, with certain modifications. The float is replaced by a light calico bag containing a little sand, the resistance of which is sufficient to form a very satisfactory fixed point. The line is looped in coils and not on a reel, and is fitted with a simple electrical indicator. An accuracy of 1 per cent. is obtainable with this arrangement.—On the distribution of matter on the surface of the earth, by M. G. **Lippmann.**—The conductivity and residual ionisation of solid paraffin under the influence of the radium radiation, by M. Henri **Becquerel.** It is easily shown that solid paraffin becomes a conductor whilst under the action of the radium emanation, and this is not immediately lost on the removal of the radium, but, although diminishing rapidly, is still appreciable during about half an hour.—The preparation and properties of cæsium ammonium and rubidium ammonium, by M. Henri **Moissan.** These substances were obtained by the action of liquid ammonia on the metals, the methods employed being similar to those previously described for sodium, potassium, and lithium. Cæsium ammonium is crystal-

line, and takes fire at once in the air. Its analysis gave figures corresponding to the formula $CsNH_3$, and the rubidium compound has an analogous composition. The solutions of these substances in liquefied ammonia have been utilised for the production of the carbides of cæsium and rubidium.—Secular perturbations of the first degree with respect to the eccentricity, by M. Jean **Mascart.**—On the visibility of the eclipsed lunar disc during the second half of the eclipse of April 11–12, by M. **Amann.** The peculiar and exceptional visibility of the eclipsed portion of the moon's disc was confined to the second part of the eclipse.—On the decomposition of a linear substitution, real and orthogonal, and on a product of inversions, by M. Léon **Autonne.**—On the value of averages in meteorology, and on the variability of temperatures in France, by M. Alfred **Angot.** It is pointed out that the arithmetical mean of a series of experimentally observed numbers is only the most probable result if the causes of error are purely accidental, and that this latter condition does not necessarily hold in meteorological observations. Observations taken in France over a period of fifty years are discussed with the view of determining between what limits this condition is satisfied.—On the electrical conductivity of selenium in the presence of bodies treated with ozone, by M. Edmond **van Aubel.** Substances after treatment with ozone, and which are capable of being attacked by it, increase the electrical conductivity of selenium, the rate of return to the original resistance being extremely slow.—On the transmission of photographs by means of a telegraph wire, by M. **Korn.** The image is produced photographically upon a rotating plate by means of the light from a vacuum tube, and the latter is worked by high frequency Tesla currents, governed by a selenium cell at the transmitting end of the wire. The rate of transmission is slow, owing to the inertia of the selenium.—On the theory of coloured indicators, by M. P. **Vaillant.** From a quantitative study of the colour of solutions of paranitrophenol and its salts, the conclusion is drawn that the definition of an indicator given by Ostwald and Nernst is incomplete.—Electrolysis of the sulphides of the alkaline earths, by MM. André **Brochet** and Georges **Ranson.** In concentrated solutions, electrolysed at 60°, sulphur, baryta and hydrogen are produced, indicating that the primary products are sulphur and barium. There is no evidence of the production of any oxidation products.—On a new method for the estimation of the halogens in organic compounds, by MM. H. **Baubigny** and G. **Chavanne.** The substances are oxidised by chromic acid mixture in presence of a silver salt; chlorine and bromine are set free, whilst iodine is completely converted into iodic acid. Test analyses of several iodine compounds prove the accuracy and convenience of the method.—The action of ethyloxalyl chloride on mixed organo-magnesium compounds, by M. V. **Grignard.**—The action of the bases of the alkaline earths upon the salts of pyrogallol-sulphonic acids, by M. Marcel **Delage.**—A new method for the estimation of glycerol, by M. A. **Buisine.** The process is based upon the production of a mixture of hydrogen and methane by the interaction of glycerol and a mixture of potash-lime and caustic potash at 350°. It has the advantage of requiring a very small quantity of material, and is very rapid.—A new test for lead and manganese, by M. R. **Trillat.**—On the comparative physiology of the two kidneys, by M. J. **Albarran.** In unit time, the two kidneys secrete different quantities of urine of different composition. There is a partial compensation in that the kidney producing the larger quantity of urine secretes a less concentrated liquid.—On a point in the anatomy of some Oculininæ and Pæciloporinæ, by M. Arm. **Krempf.**—On a cause of variation in fossil fauna, by M. H. **Douvillé.**

DIARY OF SOCIETIES.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—On the Bending of Waves round a Spherical Obstacle: Lord Rayleigh, O.M., F.R.S.—Sur la Diffraction des Ondes Électriques à propos d'un Article de M. Macdonald: Prof. H. Poincaré, For.Mem.R.S.—On the Theory of Refraction in Gases: G. W. Walker.—An Analysis of the Results from the Kew Magnetographs on *Quiet* Days during the Eleven Years 1890 to 1900, with a Discussion of Certain Phenomena in the Absolute Observations: Dr. C. Chree, F.R.S.—On a Remarkable Effect produced by the Momentary Relief of Great Pressure: J. Y. Buchanan, F.R.S.—Evolution of the Colour-Pattern and Orthogenetic Variation in Certain Mexican Species of Lizards with Adaptation to their Surroundings: Dr. H. Gadow, F.R.S.——Researches on Tetanus: Prof. Hans Meyer and Dr. F. Ransom.—The Hydrolysis of Fats in vitro by Means of Steapsin: Dr. J. Lewkowitsch and Dr. J. J. R. Macleod.—On the Optical Activity of the Nucleic Acid of the Thymus Gland: Prof. A. Gamgee, F.R.S., and Dr. W. Jones.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 5.—Annual General Meeting.

FRIDAY, MAY 29

ROYAL INSTITUTION, at 9.—Some Physical Problems of the Ocean: J. Y. Buchanan, F.R.S.

SATURDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

TUESDAY, JUNE 2.

ROYAL INSTITUTION, at 5.—The Work of Ice as a Geological Agent: Prof. E. J. Garwood.

VICTORIA INSTITUTE, at 4.30.—The Living God of Living Nature: Lionel S. Beale, F.R.S.

WEDNESDAY, JUNE 3.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, JUNE 4.

CHEMICAL SOCIETY, at 8.—Imino-ethers corresponding to Ortho-substituted Benzenoid Amines: G. D. Lander and F. T. Jewson.—(1) Formation of an Anhydride of Camphoryloxime; (2) The Mutarotation of Glucose as influenced by Acids, Bases and Salts; (3) The Solubility of Dynamic Isomerides: T. M. Lowry.—(1) Isomeric Partially Racemic Salts containing Quinquevalant Nitrogen. Part X. The Four Isomeric Hydrindamine *d*-Chlorocamphorsulphonates $NR_1N_2H_3$; (2) Isomeric Compounds of the Type $NR_1R_2H_3$: F. S. Kipping.—The Hydrolysis of Ethyl Mandelate by the Fat Splitting Enzyme, Lipase: H. D. Dakin.

ROYAL INSTITUTION, at 5.—Electric Resonance and Wireless Telegraphy: Prof. J. A. Fleming, F.R.S.

RONTGEN SOCIETY, at 8.30.—On the Electric Field surrounding the X-Ray Tube: Rev. P. Mulholland.

LINNEAN SOCIETY, at 8.—On the Anatomy and Development of *Comys infelix*; Miss Alice L. Embleton.—Scottish Freshwater Plankton: Messrs. W. and G. S. West.

FRIDAY, JUNE 5.

ROYAL INSTITUTION, at 9.—The New Star in Gemini: Prof. H. H. Turner, F.R.S.

PHYSICAL SOCIETY, at 5.—Special Meeting at University College.—Radio-active Processes: Prof. Rutherford.

SATURDAY, JUNE 6.

ROYAL INSTITUTION, at 3.—The "De Magnete" and its Author: Prof. S. P. Thompson, F.R.S.

CONTENTS.