THURSDAY, DECEMBER 5, 1901.

PASTEUR.

The Life of Pasteur. By René Vallery-Radot. Translated from the French by Mrs. R. L. Devonshire. Pp. 628; 2 vols. (Westminster: Archibald Constable and Co., Ltd., 1902.) Price 32*s*.

"L'ŒUVRE de Pasteur est admirable; elle montre son génie, mais il faut avoir vécu dans son intimité pour connaître toute la bonté de son cœur," wrote one of Pasteur's most distinguished disciples who was in daily intercourse with him.

This sentiment, so simply and so eloquently expressed by Dr. Roux, can now, thanks to M. Vallery-Radot, be shared by that larger circle of Pasteur's friends and admirers who, distributed in all quarters of the globe, knew him in his public capacity, but could not have the privilege of being included amongst his intimate associates.

There are, however, few men whose scientific writings reflect the inner life of the man to the same extent as do those of Pasteur, for with Pasteur his work was his life—his religion, and it was inseparably bound up with every action, with every aspiration.

M. Vallery-Radot has enabled us to accompany Pasteur throughout his career, to share alike in his joys and his sorrows, in his anxieties and triumphs, guiding and directing us the while with consummate skill, so that the true proportion of the actions and events which are recorded is maintained in their relation to the whole. As Pasteur's son-in-law, M. Radot has had exceptional opportunities for undertaking this biography, and already we are familiar with his workmanship in that vivid sketch of Pasteur published many years ago, in which the authorship is modestly veiled under the title "l'histoire d'un savant par un ignorant." This little volume was brought out in Pasteur's life-time; since his death we have had M. Duclaux's intellectual appreciation of his master, whom he succeeded as Director of the Pasteur Institute, Dr. Roux's sympathetic personal reminiscences of his great teacher, M. Fleury's impressionist sketch, and in England the volume in the Century Science Series, for which the writer of this notice and her husband are responsible. M. Radot's work differs from all of these inasmuch as he has had access to letters and diaries, note-books and divers documents which were to others inaccessible, and by the judicious use of which the personal element is so happily brought into relief and yet blended so harmoniously with its surroundings.

Of no man could it be more truly said that whatsoever his hand found to do he did it with all his might; the *de minimis non curat* did not exist for Pasteur. As Dean of the new Faculté des Sciences at Lille, for example, despite his passionate devotion to his researches on crystals and molecular dissymmetry, he would forsake his beloved laboratory to take his students round factories and foundries, even organising a tour in Belgium so that they might visit the industries of the country, "questioning the foreman with his insatiable curiosity, pleased to induce in his students a desire to learn."

Later, when he returns to the École Normale as administrator and director of scientific studies, in which office was included such miscellaneous duties as the surveillance of the economic and hygienic management, the responsibility for general discipline, intercourse with the families of the pupils and the literary or scientific establishments frequented by them, we find him noting down as matters for attention "Catering; ascertain what weight of meat per pupil is given at the École Polytechnique. Courtyard to be strewn with sand. Ventilation of class room. Dining hall door to be repaired."

If professors in this country have in the past had but slight encouragement to embark upon research, what would they have said to the position of Pasteur in this respect, who at the École Normale, in addition to such vexatious demands upon his valuable time, had no laboratory, but a garret only in which to carry on his investigations, whilst we hear of him later "building a drying-stove under the staircase; though he could only reach the stove by crawling on his knees, this being better even than his old attic"?

The general state of affairs connected with higher education in France was indeed at that time most deplorable, and Duruy, the enlightened Minister of Public Instruction, whilst sympathising with the lamentable position occupied by science in the country and deeply regretting the penurious policy which stifled its aspirations, was unable to make his voice heard in Cabinet councils, the other ministers, we are told by him, "being absorbed in politics."

Pasteur and Duruy had often discussed the contrast presented by the flourishing young University of Bonn, with its staff of fifty-three professors and vast laboratories for chemistry, physics and medicine, and the Strassburg faculty, with its handful of teachers, hampered in every direction by a policy of deplorable penury. It is not surprising to find Pasteur, in the anguish of his soul, well-nigh crushed by the disasters which overwhelmed his country, bitterly exclaiming in 1870:

"We savants were indeed right when we deplored the poverty of the department of Public Instruction! The real cause of our misfortune lies there. It is not with impunity—as it will one day be recognised, too late—that a great nation is allowed to lose its intellectual standard. . . . We are paying the penalty of fifty years' forgetfulness of science, of its conditions of development, of its immense influence on the destiny of a great people, and of all that might have assisted the diffusion of light."

Again he writes in a pamphlet entitled "Why France found no Superior Men in the Hours of Peril":—

"France has done nothing to keep up, to propagate and to develop the progress of science in our country. . . . She has lived on her past, thinking herself great by the scientific discoveries to which she owed her material prosperity, but not perceiving that she was imprudently allowing the sources of those discoveries to become dry . . . Whilst Germany was multiplying her universities, establishing between them the most salutary emulation, bestowing honours and consideration on the masters and doctors, creating vast laboratories amply supplied with the most perfect instruments, France, enervated by revolutions, ever vainly seeking for the best form of Government, was giving but careless attention to her establishments for higher education."

This crying need of a people was voiced by Pasteur more than thirty years ago, at a time when great national disasters were sweeping all before them; a quarter of a century later these words sound a prophetic note of warning to another nation which, with similar arrogance and similar criminal neglect, has made a fetish of political illusions whilst the very foundations upon which the soul of the people depends have been forgotten or deliberately ignored.

"Is it not deplorable, almost scandalous," exclaims the Minister Duruy, "that the official world should be so indifferent on questions of science?" Would that England had a minister who, whilst sharing such a conviction, possessed the courage to express it! Pasteur with rare prescience was never weary of insisting upon the importance of higher education; "if that teaching is but for a small number, it is with this small number, this *élite*, that the prosperity, glory and supremacy of a nation rest," and we find him again and again returning to the same theme.

M. Radot takes us step by step along the victorious path which Pasteur cleared in the conquest of the most difficult scientific problems of the day. Yet he reminds us that those imaginative people

"who would decorate the early years of Louis Pasteur with wonderful legends would be disappointed; . . . at the Arbois College he belonged merely to the category of good average pupils . . . at the examination for the *baccalauréat ès sciences* he was only put down as *médiocre* in chemistry."

But all this was to be changed, and under the inspiring influence of two such teachers as Balard and Dumas he became a student of chemistry second to none in the enthusiasm for his subject.

His discoveries in crystallography soon won for him a foremost place in the scientific world. In a letter from the great physicist Biot to Pasteur's father we have a charming tribute paid by the aged to the young philosopher.

"It is the greatest pleasure that I can experience in my old age to see young men of talent working industriously, and trying to progress in a scientific career by means of steady and persevering labour and not by wretched intriguing. That is what has made your son dear to me, and his affection for me adds yet to his other claims and increases that which I feel for him."

Biot's friendship for Pasteur, which ripened into a fatherly love and pride in his work, only terminated with his death and was one of Pasteur's most valued possessions.

It will be remembered how Mitscherlich had discovered that the two tartaric acids so familiar to chemists, while apparently identical in chemical composition, in chemical properties, in crystalline form and, in fact, in every known detail, behaved differently in solution towards polarised light. This distinguished crystallographer, unable to detect any difference in these two tartrates, asserted that they were identical in every other particular. Pasteur could not accept this conclusion as to the absolute identity of these substances in face of the fact of their different behaviour towards polarised light, and determined, if possible, to procure some of the inactive tartaric or racemic acid and submit it to an exhaustive examination. But how to procure this racemic acid? Originally obtained in 1820 by Kestner, at Thaun, through a mere accident in the manufacture of tartaric acid, it had suddenly ceased to appear in spite of all efforts to obtain it again. Pasteur's emotion was immense on hearing from Mitscherlich that a manufacturer in Saxony had again produced some racemic acid, and that he believed the tartars employed had originally come from Trieste. "I shall go to Trieste," says Pasteur, in a fever of excitement; "I shall go to the end of the world. I *must* discover the source of racemic acid, I must follow up the tartars to their origin."

Armed with letters of introduction, he starts off on his voyage of discovery and, writes a contemporary, "never was treasure sought, never adored beauty pursued over hill and vale with greater ardour."

How he succeeded in obtaining specimens and in establishing a minute difference in the crystalline structure of these two acids, overlooked by the renowned and experienced Mitscherlich, and how his fundamental discovery of the relationship which exists between crystalline form and optical activity, followed up by a series of masterly investigations, has given birth to that fertile offshoot of chemical science known as stereochemistry, is familiar to all.

The red ribbon of the Legion of Honour was his country's recognition of these brilliant discoveries in the field of chemical science. In the further prosecution of his investigations, Pasteur discovered that if he allowed one of the salts of racemic acid to ferment, the dextro-tartaric component was alone acted upon, which action in his own words he declares to be "the ferments of that fermentation feeding more easily on the right than the left molecules." At this time, when his attention was being arrested by the problems of fermentation in connection with the production of chemical compounds, he was appointed professor at Lille. Difficulties encountered by a local manufacturer in the production of beetroot alcohol induced Pasteur to turn his thoughts more especially to the phenomena of fermentation, and these studies led by a natural sequence to his throwing down the gauntlet to the great Liebig and entering single-handed upon that famous contest with the most brilliant intellects of the day as to the origin of the phenomena of putrefaction and decay.

The current contempt for Pasteur's conclusions may be realised from the following words emanating from the most distinguished chemist of the day. In 1845 Liebig wrote:—

"As to the opinion which explains putrefaction of animal substances by the presence of microscopic animalculæ, it may be compared to that of a child who would explain the rapidity of the Rhine current by attributing it to the violent movement of the numerous mill-wheels of Mayence."

Pasteur relates how, several years later, he visited Liebig in his laboratory, anxious to induce him to acknowledge the truth of his theories; he was received with kindly courtesy, but on endeavouring to approach the delicate subject he had so much at heart, Liebig, "without losing his amenity, refused all discussion, alleging indisposition."

The multiplicity and varied character of Pasteur's researches have been well-nigh forgotten by a generation which almost exclusively associates his name with the

work of his later years—rabies and its prevention. His researches on vinegar, on the diseases of wine, his laborious investigations extending over years which succeeded in disclosing the origin of the diseases in silkworms which had threatened to ruin the silk industry of France, his studies on beer, collected in a magnificent volume covering nearly 400 octavo pages, are but a few of the colossal labours which occupied his mind before he became absorbed in the study of contagious diseases.

At the ripe age of fifty-five we find him devoting himself with all the energy and enthusiasm of youth to the study of pathological phenomena. Various theories as to the origin of anthrax were in the air at the time when Pasteur determined to enter the field. M. Radot gives a most vivid account of these researches and of the hopes and anxieties to which Pasteur was a prey at this time, living as he did in a condition of intense nervous tension and excitement during their progress. Difficulties, however, never deterred, they only served to stimulate, Pasteur. The memoir in which Pasteur and his assistants communicated their successful investigations on anthrax and septicæmia to the Academy of Sciences is famous, not only on account of the manner in which they mastered the etiology of these diseases, but also for the extreme fertility and originality of the ideas and experiments which it records. Having established the identity of the virus he set to work to discover a means of combating its action, and thus he was led to those epoch-making researches in the domain of immunity which were to succeed in converting a virus into a vaccine—a malignant foe into a beneficent friend—and which have made the name of Pasteur a household word revered in the remotest corners of the globe.

M. Radot, besides giving us a faithful and fascinating history of Pasteur's scientific life and aspirations, has with the delicate touch of a master revealed the inner life of this great genius, with rare subtlety indicating the essential character of the man who,

"absorbed as he was in his daily task, yet carried within himself a constant aspiration towards the ideal, a deep conviction of the reality of the infinite and a trustful acquiescence in the mystery of the universe."

No one who reads Pasteur's speeches can fail to be struck by the lofty tone which pervades them; he sought always the highest and scorned to touch what was base; his deep religious sense communicated itself to all who were brought in contact with him, from the most exalted in the land to the poorest student who came to work under his guidance.

In one of those public utterances which in his declining years became so rare and so eagerly sought for he tells us:

"Our only consolation, as we feel our own strength failing us, is the consciousness that we may help those who come after us to do more and to do better than ourselves, fixing their eyes as they can on the great horizons of which we only had a glimpse."

This is the keynote to his life, embodying the same passionate desire to help others which stimulated him from his earliest years, but mellowed by the ripeness of advancing age, and the consciousness of a life fast drawing to a close, the burden of which was soon to be laid aside.

G. C. FRANKLAND.

A MANUAL OF MEDICINE.

A Manual of Medicine. Edited by W. H. Allchin, M.D., F.R.C.P. Lond., F.R.S. Edin., Senior Physician and Lecturer on Clinical Medicine, Westminster Hospital. Vol. iii. *Diseases of the Nervous System.* Pp. x + 417. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THE third volume of Dr. Allchin's "Manual of Medicine" is well up to the standard of its predecessors, in fact, if anything, may be regarded as rather exceeding it. Here, in 417 short pages, the student of medicine has at his command a complete and up-to-date book upon that ever-increasing domain of medicine, nervous disease. The difficulty of editing must in this volume almost have reached its maximum. When we come to consider the enormous mass of literature which has accumulated since even the publication of the last standard book upon this subject, we may perhaps appreciate the great difficulty of compressing our compendious knowledge upon nervous disease into what may, without forcing language, be called a manual. In these circumstances we can hardly expect theories to be discussed *in extenso*, or ample polemic justice to be done to controversial matter. The book is filled with terse fact, and if its readability suffers somewhat on this account, its value to the student is proportionally increased.

With the space at our command we must content ourselves with indicating rather than describing the contents of the book. Even to those out of touch with the burning problems of nervous disease, and only generally interested with the physiology of the nervous system as a part of biology, it will be manifest that the recent progress in histological method, the product of increased knowledge of bio-chemistry, has profoundly modified our conceptions of the constitution of the nervous system and also neuro-pathology.

In an introductory chapter Prof. Sherrington deals with the physiology of the nervous system in a most lucid and wonderfully succinct manner. This chapter is followed by one contributed by Dr. Aldren Turner upon the general pathology of the nervous system. Dr. Turner points out that the adoption of the conception that the nervous system consists of a series of neurons necessarily precludes us from continuing to divide affections of the nervous system above the foramen magnum from those below. The only true system of classification must be one based upon the neuronic systems primarily involved. It must, however, be admitted that a given morbid process need not necessarily confine itself to one neuronic system, but may simultaneously implicate two or more. Several other articles are contributed by the same author. The one on focal diagnosis is especially to be recommended.

With the beer-poisoning epidemic fresh in our memory we naturally turn to the article on peripheral neuritis, which is written by Dr. Purves Stewart. The different varieties of neuritis are well described, the author wisely abstaining from controversial matter. Dr. Ormerod contributes articles upon the spinal cord and its membranes and the muscular dystrophies.

The volume concludes with a most instructive and

beautifully illustrated article on medical ophthalmology, by Dr. James Taylor, and one on the medical applications of Electricity, by Dr. Bertram Abrahams.

Dr. Allchin's third volume is, in our opinion, highly to be recommended. We know of no book in the language upon this subject which will be more worth the student's, and indeed the practitioner's, while to read and to possess.

F. W. T.

PRACTICAL MATHEMATICS.

Practical Mathematics for Beginners. By Frank Castle, M.I.M.E. Pp. ix + 313. (London: Macmillan and Co., Ltd., 1901.) Price 2*s.* 6*d.*

THIS little book deserves the title of Practical Mathematics better than any work that we have seen. The subjects dealt with are arithmetic, plane geometry, algebra, mensuration and analytic geometry. The chapters on arithmetic deal with those operations in which this subject is most nearly related to algebra—such as the theory of fractions, ratio and the extraction of the square root. The part on geometry is strictly limited to constructions with rule, compass, &c., and explains the use of simple and diagonal scales; it is in no sense a course of deductive geometry such as we have in the books of Euclid. The part of the book dealing with algebra is more extensive, but still very elementary; it does not, for example, include a discussion of quadratic equations, although it shows how a quadratic expression in x can, in very simple cases, be resolved into factors. While noticing this part of the book we may point out some corrections which should be made in the next edition. Thus, in p. 76, where it is proposed to resolve $x^2 - 9x + 20$ into factors, we find the statement, "Hence $x = 4$, or $x - 4 = 0$ is a factor." The beginner should be put on his guard against such a loose mode of expression. In the next example on the same page we find, "Next put $x = + 5$, and it is found to be a factor." The factor referred to is $x - 5$. In p. 77 we have the incorrect expression, "When required to add, subtract or compare fractional expressions, it is necessary that they shall all have a common denominator." In p. 88, g is described as 32·2 "feet per second" instead of 32·2 "feet per second per second," which the majority of mathematicians have at last been forced to acknowledge as the only correct mode of speaking.

These, however, are minor blemishes which are very easily removed.

It is a cardinal aim with the author to make all his examples illustrative of questions relating to various branches of physics, and for a certain class of students (those who have already come into contact with such practical matters) this is a very good plan, because it enlists the interest of the learner in convincing him that he is applying his mathematics to something real. It is doubtful if the plan has as much value for the ordinary schoolboy who is, under our precious system of education, a complete stranger to everything in the domain of physics. Hence such questions as that in example 5, p. 88, relating to the arrangement of a number of Grove's cells, will not convey much meaning to any but students of physics. There are useful little chapters on logarithms, showing their use and illustrating several things in which beginners are very apt to make mistakes. After this we come to an explanation of the slide rule and its applications; and the remainder of the book is that which most entitles it to the name of Practical Mathematics, this portion being of value to the student who wishes to be able to apply his pure mathematics to the representation of physical results. Here there is a great deal of graphic work done by means of squared paper, and a considerable portion of the analytic geometry of right lines, circles and higher curves is expounded, the accompanying illustrations being all drawn from physics. The fundamental notions of the differential calculus are very well and simply explained by this same system of plotting on squared paper; and the ease with which the processes can be followed and understood even by beginners who have nothing but a knowledge of arithmetic and elementary algebra to go upon shows that, in our ordinary course of mathematical teaching, the differential calculus is very unnecessarily postponed—that, in other words, our mathematical course for beginners should be made eclectic in character, a portion of any subject being introduced when the mind of the student is in a state to understand it. Our present system is essentially different; we feel constrained to finish each subject before beginning another, although the finish of one subject may be much more difficult than the preliminary portion of that which is postponed; and we thus lose sight of the fact that our present divisions of mathematics are only artificial, and that mathematics is, in reality, one connected whole.

In the part of the work dealing with mensuration two planimeters are described—the Hatchet and Amsler's.

The work gives an excellent epitome of the various branches of mathematics dealt with, and it will serve as a store of very good exercises in elementary methods for all students who desire to make a practical use of their mathematical knowledge in picturing the relations between various physical quantities.

OUR BOOK SHELF.

Memorial Lectures delivered before the Chemical Society, 1893–1900. Pp. 560. With fourteen portraits. (London: Gurney and Jackson, 1901.) Price 7*s.* 6*d.*.

THE Chemical Society has done an important service to chemists and to students of chemistry by collecting these memorial lectures into one volume, and issuing it under conditions which render it accessible to readers of whom some may not be Fellows of the Society and consequently have not enjoyed the advantage of hearing the lectures when delivered or of reading them in the pages of the *Transactions.*

The lives of the men whose work and achievements are commemorated in this volume link us with the now long-distant past, and remind us of the immense strides which have been made in consequence of their discoveries and the discoveries of their contemporaries since the days when Berzelius and, later, Liebig were the dominant authorities. They remind us of the great and almost sudden advance which was accomplished between 1850 and 1865, when the modern system of atomic weights, definite ideas of valency and constitutional formulæ were finally established. The student who aspires to understand by what methods and with what laborious effort the greatest degree of scientific accuracy is alone attainable must read about the work of Stas on atomic

weights. If he wants to know how physical ideas of the constitution of matter and the nature of electrical charges are applied to chemical problems he will read Fitzgerald's lecture on Helmholtz. If he looks for the story of Pasteur's wonderful scientific career and how the chemist applied his chemical experience to the difficult problems of disease and life he will find it admirably told by Frankland in this volume. There are fifteen of these essays in the book, and each possesses an individuality of its own and in general a very high standard of literary quality is reached.

It must, of course, be admitted that the volume does not give the whole history of the progress of chemistry during the last half century, for of course these lectures relate only to deceased *foreign* members of the Chemical Society. The work of Williamson, Odling, Frankland sen., Perkin, Gladstone and Crookes, for example, is only incidentally referred to, for happily these Fathers of Modern Chemistry, with one exception, are still with us. Neither does the volume include any account of the life-long labours of Berthelot, the senior Foreign Fellow of the Society, whose celebration of the fiftieth year of his scientific activity has so recently attracted the sympathetic attention of the whole civilised world. But the rising generation of scientific men may well be reminded in the words which M. Berthelot is reported to have spoken recently in the presence of the President of the French Republic at the Sorbonne, that it is not they who are making the science of the time, but their scientific ancestors. "If each of us adds something to the common domain in the field of science, of art, of morality, it is because a long series of generations have lived, worked, thought and suffered before us."

Experimentelle entomologische Studien vom physikalisch-chemischen Standpunktaus. Von Prof. P. Bachmetjew. Mit einem Vorwort von Prof. Dr. August Weismann in Freiburg i. Br. Erster Band. Temperaturverhältnisse bei Insekten. Pp. x + 160, mit 7 Figuren im Text. (Leipzig: Wilhelm Engelmann.) Price 4*s.* net.

HITHERTO the best-known researches into the temperature of insects have been those directed to the effects produced on the development or coloration of perfect insects reared from larvæ or pupæ which had been subjected to carefully graduated variations of high or low temperatures. There is, however, a very considerable literature, chiefly scattered in foreign periodicals, dealing with the temperature of insects from a much wider standpoint, especially as to their power of resistance to heat or cold. In the present work Prof. Bachmetjew, who commenced his researches in 1898, and who has already published some preliminary papers, has brought together and classified these scattered materials, adding to them the results of his own work.

The first section is devoted to the effects of temperature, moisture, movement, food, &c.; and the second to the extreme limits of heat or cold which insects are capable of resisting in their various stages. The bibliography at the end of the volume comprises, with additions, upwards of 200 references. The importance of this little volume of 160 pages is far greater than its unpretentious appearance would indicate, more especially as a very useful basis for further investigations and experiments. It is freely illustrated with diagrams and tables, and is too technical for a very detailed notice. The second volume, now in preparation, will be devoted to "Einfluss der äusseren Faktoren auf Insekten."

Flora of Guernsey and the Lesser Channel Islands. By Ernest David Marquand. Pp. viii + 501. (London: Dulau and Co., 1901.) Price 10*s.* 6*d.* net.

THE author of this work is to be congratulated on the way in which he has succeeded in his task of bringing up to date the state of our knowledge of a very interesting group of islands. The number of plants recorded in this volume for Guernsey and the lesser islands collectively is as follows:—

Flowering plants	828	species
Ferns and fern allies	29	,,
Mosses	156	,,
Hepaticæ	41	,,
Fungi	624	,,
Lichens	334	,,
Algæ	641	,,
Total	2653	species

The flowering plants and ferns are arranged and named in accordance with the last (eighth) edition of Babington's "Manual of British Botany." Each island is separately dealt with, and separate indexes are given for Guernsey, Alderney and Sark—the other five islands, viz. Herm, Jethou, Lihou, Crevichon and Burhou, not requiring one. For Burhou, indeed, less than a score flowering plants and ferns are recorded.

From the descriptive notes we learn that Guernsey is the most densely populated island on the face of the earth—a fact which the visitor, rambling through its country lanes, would find hard to realise. During the last twenty years the fruit-growing industry—owing largely to the extremely favourable climate—has advanced enormously. "At the present day there are certainly scores, if not hundreds, *of miles* of greenhouses in the island. . . . Every week-day during the spring and summer months large shiploads of vegetable produce leave Guernsey for the English markets, as many as 28,000 baskets and crates having been dispatched in a single day." Owing to draining operations and increased cultivation generally some of the rarer local plants will, before long, certainly disappear.

The first record for each plant is given, and interesting notes on its native names and former and present uses, &c. On p. 156 we find a blunder—one, however, repeated in every local flora, and indeed in many much more pretentious works which we have consulted—the plant there noted by Mr. Marquand is certainly not *Lycium barbarum*, but doubtless *L. chinense*. This last is a very different plant from the true *L. barbarum*, which is a thorny small-leaved desert plant—a native of North Africa—which is not anywhere naturalised in Britain or the British Islands. *L. chinense*, on the other hand, is a Chinese plant which readily naturalises itself.

G. N.

Water and Water Supplies. By J. C. Thresh, M.D., D.Sc. Medical Officer of Health to the Essex County Council. Third edition, revised and enlarged. Pp. xv + 527. (London: Redman, Limited, 1901.) Price 7*s.* 6*d.* net.

THIS work deals with the chemical composition and physical characters of water; the various sources from which it may be collected; the different ways in which it may be polluted and the effect on health of such pollution; the interpretation of the results of chemical analyses of water; the methods of purification and softening of water; the quantity required for domestic and other purposes; the protection of water supplies; the means of storage and distribution; and the law on water supplies.

Thus it will be seen that the subject is considered from every point of view of importance to those who are interested in providing a good water supply for domestic or trade purposes, and that the work appeals to a wide clientèle, to whom we have no hesitation in confidently recommending it.

For general accuracy, clear exposition and arrangement of subject-matter, and for evidence of a wide practical experience on the part of the writer, this work deserves to take a prominent place in public health literature. The book is well printed and tastefully bound.

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.*]

Automatic Actions.

IN the interesting paper on "Reflex Action" by Dr. W. Benthall, published in your issue of September 5, he speaks of acquiring some feat of manual dexterity in which, with practice, the required muscular action becomes automatic. It seems to me that the same rule applies to many operations which are generally regarded as purely mental, such as in the use of the first four rules in arithmetic, in writing grammatically and spelling correctly, and in speaking any language. If you think, the action becomes laborious and in all cases the result is uncertain. In the case of spelling this seems to occur to every one, so that if you have to look up one word in a dictionary, which shows that you have begun to think about spelling, you have immediately to look up a number of others. Many people who are employed as clerks, &c., no doubt in adding a column of figures have their minds completely blank without their knowing it. In my own case, both at school and afterwards, I was very slow at this process and very uncertain of the results if the figures were numerous, as in a money column, but I found out, more than twenty years after I left school, that by thinking, not of the figures, but of nothing, the process was easy and rapid and the results correct. In speaking, say, French, if a person has to think of grammatical rules, the gender of nouns, &c., he can never speak fluently; to do so he must think of what he intends to convey and let the words take care of themselves.

Lower down Dr. Benthall quotes Dr. Lewis Robinson, who says: "The horse roamed in a wild state, over plains of more or less long grass and low bushes. When a horse is alarmed he throws up his head to get as wide a view as possible. The cow, on the other hand, keeps her head low, as if to peer under the boughs which covered the marshy grass of her jungle home." Cases of terror are only occasional occurrences amongst domesticated animals, but in the wild state the necessity of caution in the first movements on awakening from sleep, for fear of attack by some lurking foe, is evident. Now when a horse rises he gets on his fore feet and lifts his head high, whilst the cow rises on her hind legs first and keeps her head low. The horse being naturally a timid animal and rather unweildy in the process of getting on his legs has learned to sleep mostly standing and so be ready to move off at once, or kick as required; hence a stableman always speaks to a horse before approaching him from behind to make sure that he is awake and so unlikely to kick. WILL. A. DIXON.

Sydney, October 14.

Does Man use his Arms in Locomotion?

THE letter by Mr. Martin under this heading in your issue of November 28 raises the two interesting questions, (1) whether the swinging of the arms in walking and running serves any useful purpose as an aid to progression, and (2) whether this movement is a vestige, as Mr. Martin suggests, of the progression on all-fours of man's ancestors.

The following considerations may be of interest, though they are probably not put forward for the first time.

The movement of the legs in opposite directions in different planes involves a reaction, in the form of a couple, upon the trunk, tending to rotate it alternately in opposite directions about a vertical axis. That such a rotation does take place normally, when the arms are at rest, can be seen if the latter are folded upon the breast over a long light horizontal rod to serve as an indicator. This is very obvious when running. Now the swinging of the arms, each in unison with the leg of the other side, introduces an opposing couple which more or less completely balances, about a vertical axis, the reciprocating motion of the legs. The importance of the efficient "balancing" of the reciprocating and revolving parts of a railway locomotive, if steady and economical running is to be obtained, is well known.

That children and even adults, when compelled to crawl upon all-fours, naturally and unconsciously adopt the movements of the limbs common with four-legged animals is generally considered an indication that man has retained the instinct for this mode of progression, though the conditions for its adoption may seldom occur. It seems reasonable to suppose that the swinging of the arms in walking and running is a modification of this instinct for a modified purpose. C. O. BARTRUM.

17, Denning Road, Hampstead, N.W., November 30.

Folklore about Stonehenge.

I HAVE been waiting for more able pens than mine to corroborate Rev. Osmond Fisher's letter on the *culhes lapidum* in a recent issue of NATURE.

The same tradition about a loaf being placed on each stone to facilitate counting occurs in other places where sarsens have been objects of reverence in bygone ages. In April, 1895, Mr. Albany F. Major (hon. sec. Viking Club) and myself went on a visit to Kits Coity House above Aylesford, Kent. At the foot of Blue Bell Hill on the way to Kits Coity there are a number of sarsens in a field. On inquiring of a rustic as to their whereabouts, in directing us to them he informed us that a baker had made a bet he would count them and placed a loaf upon each stone in order to count them correctly. This is a slight variant of Mr. Fisher's statement about Stonehenge, but the underlying idea is the same. R. ASHINGTON BULLEN.

The Vicarage, Pyrford, Woking.

PRESERVATIVES AND COLOURING MATTERS IN FOOD.

THE report of the Departmental Committee upon this subject was issued last week and will be assuredly welcomed by all interested both in the public health and also in the trades concerned. The work of the Committee has been noticed at length in the lay Press and we think, speaking generally, has given satisfaction. Here we shall refer more particularly to the scientific aspects of the report. The Committee was practically a committee of experts, and we venture to think this precedent might be followed more frequently in the appointment of committees upon kindred subjects; trade interests are safe in the hands of impartial experts, and the exclusion of the trade from a committee of the kind saves time and, we think, also tends to the attainment of a most important desideratum, viz. unanimity.

For some time past there has been a large and apparently influential party of alarmists with regard to the use of preservatives. These have all been heard at length by the Committee which has just reported. Their evidence consisted for the most part of elaborate *a priori* argument, in support of which the most profound erudition was occasionally produced; but, as the report politely says, the opinion expressed was not always based directly upon fact. In fact, if an inquirer turns the 500 pages of the Blue-book over in search of unequivocal instances of injury to health from preservatives or, indeed, colouring matters in food he will be lucky if he finds a single one. There is no doubt some difficulty in fastening definite injury upon so subtle a cause, especially since heretofore the presence of preservatives has not even been declared. Yet, nevertheless, for the last two years practically the whole medical profession has been well alive to preservatives in food being a possible source of injury to health, and yet no definitely ascertained case, or practically none, has been forthcoming. Upon such data it is obvious that the prohibition of preservatives *en masse* was out of the question, and the recommendations of the Committee practically resolve themselves into the regulation and control rather than the prohibition of preservatives. There are, however, two exceptions to this; formaline or formic aldehyde is prohibited altogether, and all preservatives and colouring matters are prohibited in milk. The decision with regard to formic aldehyde might strike the casual observer in that nowhere in the report is it directly stated that this substance in the quantities necessary is injurious to health; a peculiar difficulty, however, arises with regard to it, viz., the practical impossibility of quantitative control. It is obvious that a substance of such

potency in unlimited quantity could not be sanctioned in food. The other exception, milk, is obviously also upon a different level; the fact that it forms the staple diet of invalids and children renders it especially important that it should be as pure as possible. It was, further, quite apparent from the evidence that the milk supply of London could be adequately maintained without preservatives, and, further, that these substances tended to mask uncleanly dairying. For the prohibition of colouring matter in milk there seems less reason. Annatto is admittedly harmless, and if the recommendations of the Milk Standardising Committee be adopted the fat standard will be uniform, and hence the colour will no longer be, at any rate in this regard, deceptive. Anything which improves the appearance of food, without it is harmful or done with direct intent to defraud in the physiological sense, that is to mask an actual nutritive deficiency, should be encouraged in that by pleasing the senses we can often help the digestion and, further, often save actual waste, as people will not eat what does not look nice.

This brings us to one point upon which, apparently, the Committee do not agree, viz., the use of copper sulphate for rendering preserved vegetables and fruits permanently green. Three members of the Committee recommend the prohibition of this practice, but Prof. Tunnicliffe is of the opinion that the amount of copper should be restricted to half a grain per pound and declared. The difference seems to be one of general principle *versus* specific fact. The Committee regard the addition of a substance to food which in certain quantities is undoubtedly poisonous to be undesirable in any quantity. It appears, however, that it is very questionable whether the copper compound actually present in the green peas is poisonous. Prof. Tunnicliffe's experiments show clearly that only a relatively small moiety of the copper is absorbed, or at any rate remains in the human system, when it is ingested in the form in which it occurs in preserved peas. These results are practically identical with those obtained by Brandl in the German Gesundheitsamt. People have taken peas greened with copper for almost half a century and no case of chronic or acute copper poisoning has so far been traced to this cause. We cannot agree that evidence of the injurious effect of copper would be difficult to obtain; copper chemically is one of the easiest substances to detect, and physiologically it produces well-marked and fairly characteristic symptoms. Had copper poisoning from coppered peas occurred, we think it would not have escaped detection. It is at any rate to be hoped that we shall not be consigned everlastingly to brown peas without further investigation.

Some surprise may perhaps be felt that salicylic acid was not prohibited, as this substance is undoubtedly possessed of active medicinal properties; it is, however, stringently controlled, only one grain per pound or per pint being allowed. This substance is a very active antiseptic, and is especially useful in jam making and temperance beverages. The complete sterilisation of jam is very apt to break up delicate fruits which it is certainly a pleasure to have whole. Many experiments have been made with salicylic acid, and in the quantities recommended by the Committee it seems quite harmless.

The appendices to the report will be full of interest to the expert; they comprise reports on very complete physiological experiments handed in by Prof. Tunnicliffe, being his own work in collaboration with Dr. Rosenheim and others, also reports of visits to Ireland and Denmark and many other invaluable reference data.

The work of the Committee must certainly be designated as thorough in the extreme, and their recommendations as eminently sensible. In particular we consider the suggestion as an excellent one that machinery should be provided either by the Local Government Board or by the formation of a separate Board of Reference for exercising control over the use of preservatives and colouring matters in food. It is sincerely to be hoped that legislation on the lines of the report will not be delayed; the necessity for it is urgent, as anyone can see who follows the conflicting decisions given in the law courts under the present Sale of Food and Drugs Act.

PRZEWALSKI'S HORSE AT WOBURN ABBEY.

A PERIOD of twenty years has elapsed since Poliakoff described an apparently new species of wild horse obtained by the late Colonel Przewalski in the deserts of Mongolia, under the name of *Equus przewalskii*. Although only a single example was then obtained, much interest attached to the discovery, as the animal appeared from the description to be in several respects intermediate between the domesticated horse and the wild asses, or, at any rate, the Asiatic representatives of the latter. For a long period nothing more was heard of the animal, and zoologists were uncertain whether they had to do with a real species or a hybrid, or possibly with one of the feral or wild representatives of the common horse. Within the last few years, however, other specimens—some alive—were received in Russia, and one skin was sent to the Paris Museum. Although no very detailed or well-illustrated description of them has hitherto appeared, these specimens appeared to demonstrate that Przewalski's horse was entitled to rank as a distinct species.

Still, without making a visit to Paris or Moscow, English naturalists had no opportunity of satisfying themselves by actual inspection as to the distinctness of this interesting animal, and the figures hitherto published left several important features in obscurity. The acquisition by the Duke of Bedford of a drove of twelve fine colts (imported by Mr. C. Hagenbeck, of Hamburg) has brought this unsatisfactory state of affairs to a close, and it is now possible to study the characters of the species (in an immature state) with some approach to exactness.

The colts at Woburn Abbey, which were foaled last spring or summer, are about the size of Shetland ponies; and, if we may judge by the absence of "legginess" in their build, do not seem likely to grow very large. In general appearance they are much more like ponys than donkeys, the ears being short and the tails haired to within a comparatively short distance of the root, although there appears to be a certain amount of individual variation in this respect. Eleven out of the twelve have, however, white muzzles, which communicate to the head a somewhat asinine appearance. All are in their winter (or ? first) coats, which are of a dun colour, with the front of the legs dark brown or black, the mane and tail being also black. The mane is at present upright, but exhibits a slight tendency to fall over, which may increase with age; and there does not seem, at least in most cases, to be a distinct forelock. Most of the colts show no dorsal stripe, although in one or two there is a short one on the rump. There is no trace of a shoulder-stripe, or of dark barrings on the legs. Both fore and hind legs have callosities. So far as I can recollect, the underparts are lighter than the back. In young animals the true form of the hoofs is not fully developed, but I think the hoofs of these colts are of the relatively large size characteristic of the horse and the Asiatic wild ass.

The Woburn colts render it quite certain that *Equus przewalskii* is a true species and not a hybrid. It is equally clear that it is perfectly distinct from the kiang and all other races of the Asiatic wild ass.

The only other animal with which Przewalski's horse could be identical is the tarpan, or wild (or feral) horse of the Kirghiz steppe, which, as I am informed, is now extinct. Tarpan are, however, described by Pallas as

having a distinct dorsal stripe on the otherwise dun back, and a well-developed forelock, while the muzzle, with the exception of the nose[1] (which is whitish), is said to be black, and the tail, which appears to be haired to the root, is rather short and bushy in winter. Moreover, the colour of the tail and mane is said to be reddish-brown. Nothing is stated with regard to the front of the legs being black.

So far as can be determined from this description, the tarpan appears identical with *Equus caballus* (of which it is probably the ancestral form), which is certainly not the case with *E. przewalskii*.

But another important point arises in connection with the animal under consideration. Naturalists commonly divide the existing species of Equus into two groups, the one containing only the horse, and the other the asses and zebras. Przewalski's horse will, however, clearly find a place in the former group, and as this animal approximates in some respects to the kiang, which differs from the African wild asses by its shorter ears, larger hoofs (especially the front pair) and absence of a shoulder-stripe and bars on the legs, I am inclined to think that the horse, Przewalski's horse, and the kiang (Asiatic wild ass) form one natural group, and the African wild ass, quagga and zebras a second. This arrangement will harmonise with distribution much better than the old one

Taking the tarpan as the wild representative of the horse, it will be noticed that all three members of the first group agree in the general absence of the sh oulder-stripe and of dark markings on the legs. And the question then arises, how is it that certain domesticated horses (especially dun-coloured ponies in the Punjab) show both these markings? Can it be owing to a cross with the African ass, or is it due to reversion to the common ancestor of the equine genus? R. L.

TYCHO BRAHE'S OBSERVATORY.

IT was mentioned in a recent article on the tercentenary of Tycho Brahe's death (p. 6) that an account of excavations made in the island of Hveen has been published by Prof. Charlier, of Lund.[2] As Tycho's observatory has thus again attracted attention, it may not be out of place to give a short description of it as it was three hundred years ago, and of the very few remains of it now brought to light.

Tycho's magnificent buildings were destroyed less than twenty-two years after his death. In 1623 a mason was paid for 60,000 bricks "which he had pulled down and renovated from the old castle," and they were used to build a new dwelling-house at a little distance, which in its turn has disappeared within the last hundred years. Apparently the peasants of the island helped themselves to bricks and stones as much as they liked, as part of the foundation-stone (laid by Tycho's friend the French envoy, Charles de Danzay) was recently discovered in the wall of an outhouse of a farm on the east coast of the island, still showing part of the Latin inscription and the date 1576 August 8. When Picard was sent over by the Paris Academy, in 1671, to determine the geographical position of Uraniborg, only the foundations of the house and the greater part of the ramparts surrounding it were still intact, while on the site of the observatory only a slight hollow in the ground was noticeable. Picard did not trouble himself about making excavations, and apparently everything was left undisturbed until 1823, when the clergyman of the island, Ekdahl, made careful excavations. At Uraniborg he found the deep well which was under Tycho's kitchen and still supplies the neighbourhood with excellent water, while parts of the foundation-walls and some slight remains of the laboratory (in the basement of the house) were also unearthed. These must have been covered over again, as nothing was visible on this spot until the present year, when the same trifling ruins of Tycho's beautiful residence were again laid bare; but as nothing of any scientific interest was found, we may at once pass to the underground observatory, of which much more distinct traces still remain.

Uraniborg, the stately residence of Tycho Brahe, was finished in 1580 and contained four observing rooms, two at the north and two at the south end of the building. But already a year or two later a large meridian quadrant was erected in one of the sitting-rooms, and very soon, as the work increased, it was found that even with this addition to the equipment more instruments were wanted. In 1584 an observatory was therefore built on a low hill

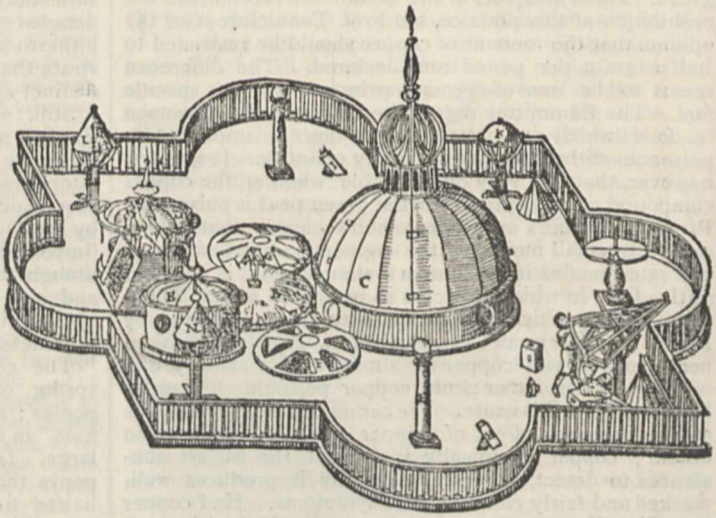

FIG. 1.—Stjerneborg Observatory, seen from the west.

about a hundred feet south of the south corner of the enclosure of Uraniborg and slightly to the east. This observatory, of which we here give a view from the west and a plan,[1] was called Stellæburgum (Danish, Stjerneborg); in it the instruments were placed in three subterranean rooms (C, G and F on the plan), of which only the roofs rose above the ground, so that they were well protected from the wind. The entrance was to the north, and in the centre was a study, lighted by four small windows just above the ground, and which could be heated by a stove in a recess (at P), while off it there was an alcove with a bed where Tycho could rest during cloudy intervals. In 1585 two other rooms for instruments (D and E) were added, but the floors of these were almost on the level of the ground, probably because he had found it inconvenient not to be able to observe stars near the horizon from the three underground rooms. The whole was surrounded by a low wooden paling, forming a square with sides 57 feet long, with semicircular bends at the middle of each side of 20 feet diameter, and stone piers were placed inside the

[1] The expression "nose" is a little ambiguous, but the figures do not show a white muzzle like that of *E. przewalskii*.

[2] "Utgräfningarna af Tycho Brahe's observatorier på ön Hven sommaren 1901." Beskrifna af C. V. L. Charlier. 20 pp., 4to, with 3 plates. (Lund, 1901.)

[1] Taken from the writer's book, "Tycho Brahe," by permission of Messrs. A. and C. Black.

enclosure, on which portable instruments could be used when necessary.

In the centre of each crypt was a large instrument, the floor rising gradually by circular stone steps (shown on the plan) up to the walls. The floor of the crypt G was, however, flat; in it was placed a sextant of 5½ feet radius for measuring angular distances in any plane. In the southern crypt (C) there was a large equatorial instrument, consisting of a declination circle of 9½ feet diameter, revolving round a diameter parallel to the earth's axis, and having a semicircle of 12 feet diameter, supported on stone piers and representing the northern half of the equator. In the crypt F stood a quadrant of 7 feet radius, enclosed in a square and with an azimuth circle on the wall, in D another quadrant somewhat smaller and in E a zodiacal armilla like those used by the ancients. Of these instruments those in C and F were the most important, and an immense deal of valuable work was done with them.

Of this observatory and of the instruments in it very full and well-illustrated descriptions were published by

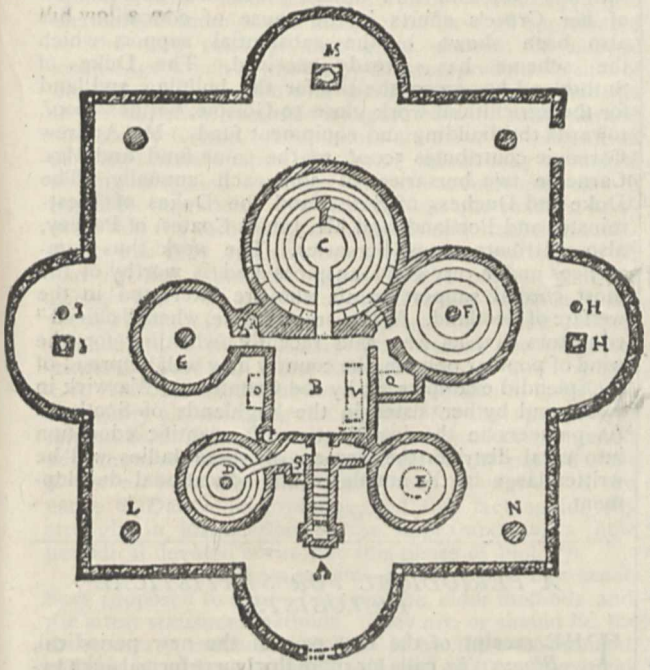

FIG. 2.—Plan of Stjerneborg:—A, entrance; B, study; C, crypt with largest armillæ; D, crypt with quadrant: E, crypt with zodiacal armillæ; F, crypt with largest quadrant; G, crypt with sextant; H, I, stone piers for portable armillæ; K, L, N, T stands for sextants; M, stone table; O, Tycho's bed; P, stove; V, table: Q, bedroom for assistants; S, unfinished underground passage towards Uraniborg.

Tycho. When he left Denmark he took all his instruments with him except the four largest, two of which were those in the crypts C and F, and the large equatorial was actually used by an assistant to observe the partial eclipse of the sun of February 25 (March 7), 1598.[1] They were, however, subsequently dismounted and sent to Bohemia, where every single instrument from Hveen was destroyed during the thirty years' war, except Tycho's large star-globe, which found its way back to Denmark only to perish in a great fire in 1728.

When Ekdahl, as already mentioned, examined the site of Stjerneborg in 1823–24, he found without difficulty the floors of the central study and of all the crypts more or less well preserved, one of them (F) being almost perfect, with the four circular steps and the short stone pillar in the middle on which the quadrant had been fixed. In the course of years everything became again covered with earth and grass except the crypt F, which was always visible, though generally more or less full of water. It furnished a valuable clue to the unit of linear measure employed by Tycho, as d'Arrest, in 1868, found the diameter of the crypt to be 11⅓ Paris feet, which must be equal to the diameter of the azimuth circle of the quadrant which Tycho states to have been nine cubits. This gives one cubit = 16·1 English inches = 40·9 centimetres. Tycho, however, also makes use of feet, and d'Arrest found to his surprise, on measuring the length of the ramparts round Uraniborg, that the whole place was much smaller than the figures given by Tycho had led him to expect, the enclosure being only 233 French feet square instead of 300. The discrepancy was, however, easily cleared up, as Picard had carefully measured the great star globe in 1671, which gave one Tychonic foot = 0·815 English = 24·9 centimetres. These figures are of importance, as it is of interest to know the exact dimensions of the instruments, by means of which so great a revolution in practical astronomy was carried out. For instance, the radius of the great quadrant (in F) was five cubits long; one minute of arc was, therefore, 0·6 millimetre in length, and as Tycho says that he could by his transversal divisions distinguish 10″, this means that he could read off the arc to a tenth of a millimetre. In reality the accuracy attained was hardly as great, the probable error of one measure of altitude being certainly more than half a minute. But even this was a wonderful advance on what had been possible before Tycho's time, when errors of three or four minutes were unavoidable.

During the past year the site of the observatory has again been thoroughly excavated under the supervision of the Swedish inspector of antiquities and Prof. Charlier, of Lund. From the account published by the latter it appears that the tiled floor of the central study is almost perfectly preserved; it is 4 metres long (from north to south) by 3½ metres broad. The floor of the alcove where Tycho's bed stood is also visible, the dimensions being only 185 by 125 cm. As it seems to have been completely underground, this tiny and grave-like bedroom can hardly have been a healthy place of rest, and it is to be hoped that the energetic observer did not use it very often. The floor of the study was found to be two metres below the ground. As Prof. Charlier's account is in Swedish, it may not be useless to give here a summary of the results of his examination of the five crypts. Of D, G and C the floors are left, all on the same level as the floor of B, and in D also the short pillar to which the lower end of the vertical axis of the quadrant was attached. The polished stone floor of E was 125 cm. above that of the study B and the steps leading up to it from the little vestibule north of the study are still intact. But the crypt F is almost in perfect preservation, with its four steps, the floor being 122 cm. below that of the study (or 10 feet below the ground), the inner diameter of the lowest step being 88 cm. and the outer diameter of the top step 345 cm. The top step was exactly on a level with the floor of the study. As the diameter of the top step was of importance for fixing the length of Tycho's cubit, it was measured again by a second observer, who found 354 cm. The mean of the two measures gives 1 cubit = 38·8 cm., agreeing sufficiently well with the 40·9 found by d'Arrest. Prof. Charlier found the value of a Tychonic foot from measures of the length of the foundation-wall of Uraniborg equal to 23·8 cm.; but as Tycho only says that the side of the square was "circiter pedes 60," this result can hardly be as accurate as that deduced from Picard's measure of the star-globe, as it seems likely that the latter was exactly 6 Tychonic feet in diameter, which Picard found equal to 55½ French inches.

[1] See *Monthly Notices* R.A.S., vol. liv. p. 439.

The account of the recent excavations of Tycho's observatory thus forms a valuable supplement to the description published by Tycho himself. The idea of seeking shelter from the wind, by erecting his large instruments a couple of feet below the level of the ground, was a good one, and on the small island the force of the wind was doubtless not a negligeable quantity, particularly as the observatory was situated almost at the highest point of the island, about 160 feet above the sea, which is visible in all directions except in the south-east. Picard remarked that except where some hills in Scania rise to an altitude of 11′, he had often seen the stars down to the very horizon, which he considered very surprising, as this was never possible at the Paris Observatory, although the latter was about 120 feet higher than the level of Tycho's observatory. But the example thus set by Tycho was not followed; for more than a hundred years the object seemed generally to be to get as near to the stars as possible by placing observatories on the top of towers and high buildings—and in the midst of crowded cities. The nineteenth century has reverted to Tycho Brahe's ideas by building observatories at some distance from cities and with the instruments at very moderate heights above the ground. Another idea of Tycho's, which was not adopted for several centuries, was to have a large staff of assistants, among whom the work of the observatory was divided. He had cherished the hope for many years that the institution founded by him would be made a permanent one and not come to an end with his own life. Unfortunately he did not succeed in getting this settled in the lifetime of his benefactor, King Frederic II., and when he finally found that not only was it hopeless to expect a permanent endowment, but that even some of the valuable grants he had enjoyed for years were taken from him, he resolved to try if some other monarch would carry out his favourite idea and found a public observatory on a large scale. But Tycho had been very many years in his grave before this was done anywhere.

J. L. E. DREYER.

TECHNICAL SCHOOLS FOR RURAL DISTRICTS.

ENCOURAGED by the success which has attended the work of her sister, the Countess of Warwick, at Bigods, near Dunmow, in Essex, the Duchess of Sutherland has boldly entered upon a scheme for providing a technical school in a still more remote rural district, viz. near Golspie, on their Dunrobin estate in Sutherlandshire. No provision for secondary and technical education in the Scotch Highlands at present exists, and the proposed school must meet a long-felt want. The draft scheme which has been drawn up by the Duchess with the cooperation of Prof. Meldola provides for the education of fifty pupils in the principles of those sciences which bear in any way upon the local industries, including agriculture. The pupils will be taken from the elementary schools and admitted only when fully qualified to take advantage of the secondary training offered by the Sutherland school. In view of the excellent character of the elementary teaching in the Scotch schools, there should be no difficulty in finding a constant supply of promising pupils, the more especially as the new school is intended for board and residence and caters for the four counties of Sutherland, Ross, Cromarty and Caithness. Like Bigods, the Sutherland technical school is to be mixed and the curriculum adapted to the requirements of boys and girls. As stated in the scheme:—

"It is impossible that education in the Highlands should continue on the present lines. There is practically no technical training whatever. The old form of 'classical' education is still persisted in, and often a whole school suffers for the sake of three or four clever pupils who win the bursaries which send them to the University, from whence they issue as clerks, doctors or ministers as the case may be. The others are left to drift into idleness or to go away south to add to the population of our already over-crowded cities. The overcrowding of the fisher class is undisputed, and the dearth of skilled masons, carpenters and artisans, or competent hand-workers in the north, apart from the homespun tweed industry, is remarkable. There have been many peripatetic technical classes carried on under the County Councils and School Boards in the north, but this is the first technical school of the kind that has been started in the Highlands. It should be the pioneer of much educational reform, and it is started with a great belief in its ultimate possibilities."

The scheme has been considered by many educationists and has been approved of by Lord Balfour of Burleigh, Mr. Struthers, of the Scotch Board of Education, Sir Swire Smith, Mr. James Baker, Prof. Magnus Maclean and others. Practical appreciation of her Grace's efforts in the cause of education has also been shown by the substantial support which the scheme has already received. The Duke of Sutherland has given the site for the building and land for the agricultural work close to Golspie, besides 5000*l.* towards the building and equipment fund. Mr. Andrew Carnegie contributes 5000*l.* to the same fund and Mrs. Carnegie two bursaries of 30*l.* each annually. The Duke and Duchess of Sutherland, the Dukes of Westminster and Portland, and Mr. James Coates, of Paisley, also contribute annual bursaries. The work thus commences under very good auspices and is worthy of the most cordial support by all who are interested in the welfare of Scotland. At the present time, when "official" educators are, as was said recently, whistling for the wind of popular opinion, the country may well be proud of the splendid examples set by the Countess of Warwick in Essex and by her sister in the Highlands of Scotland. As pioneers in the introduction of scientific education into rural districts the names of these ladies will be written large in the annals of our educational development.

A PERIODICAL FOR STATISTICAL BIOLOGISTS.[1]

THE receipt of the first part of the new periodical, *Biometrika*, calls for more than mere formal acknowledgment. The methods of investigating biological problems statistically may be looked upon as having their origin in this country, and the names of the editorial staff are those of the pioneers in this modern departure—Francis Galton, and Profs. W. F. R. Weldon and Karl Pearson, associated with Prof. C. B. Davenport, of the University of Chicago. The part received is prefaced by an editorial article setting forth the scope and defining the spirit of the publication and an article on biometry from the pen of Mr. Galton. An admirable figure of the Darwin statue in the University Museum at Oxford, reproduced from a photograph by Mrs. E. B. Poulton, forms an appropriate frontispiece, the motto "*Ignoramus, in hoc signo laboremus*," being printed below the illustration. The papers contributed to this first part are seven in number, including those already mentioned. Prof. Dr. F. Ludwig writes (in German) on problems and materials for variation statistics; Mr. A. O. Powys con-

[1] *Biometrika*. A Journal for the Statistical Study of Biological Problems. (Cambridge: University Press. New York: The Macmillan Company.) Price 10*s*.

tributes data for the problem of evolution in man, anthropometric data from Australia; Miss Beeton and Prof. Pearson furnish a paper on the inheritance of the duration of life and the intensity of natural selection in man; Mr. E. T. Browne writes on variation in *Aurelia aurita*, and Prof. Weldon on a first study of natural selection in *Clausilia laminata*.

This first list of contributions augurs well for the future of an undertaking which deserves support from all workers in science who are interested in the theory of organic evolution in its broadest applications. The points of contact between mathematicians and biologists have hitherto been but few, and the time is yet remote when we may look for the advent of a skilled mathematician who shall also be an expert biologist, or *vice versâ*. But although the modern biologist may be unable to follow the mathematical processes of the new method, he will assuredly be impressed with the importance of the results, and such a work as that which has now been launched will serve as a common meeting ground for both classes of workers. The recognised methods of studying living organisms from the points of view of systemy and taxonomy, embryology, histology and anatomy, bionomics and distribution have all contributed to the sum total of that great division of natural knowledge which is known by the comprehensive title of biology. Side by side with these we must now place the newer statistical methods inaugurated with such marked success by Galton. This latest claimant to recognition as a legitimate weapon of scientific attack may be looked at with suspicion by those who are accustomed only to the older methods. We may remind our readers, however, that the value of measurement and statistical treatment was fully realised by Darwin, as made clear in one of the editorial articles in the present part of *Biometrika*. We may point out also that Wallace in his "Darwinism" (1889) fully recognised the value of such methods, and made considerable use of the measurements of lizards by Milne-Edwards and of birds by Mr. J. A. Allen for his discussion of the question of individual variability as furnishing the material for the operation of natural selection. Such data were imperfect compared with the modern requirements of statistical methods, but so far as they went they have been of service to the cause of Darwinian evolution, and this fact, again, tells strongly in justification of the appearance of a new periodical devoted entirely to this phase of biology.

There is no real antagonism—as some men of science have supposed to exist—between the older methods and the latest statistical methods. They are, or should be, on the contrary, mutually helpful. If by the measurement of large numbers of individuals and the mathematical treatment of such data the trend of evolution in any species can be detected, here at once is a suggestion for the observing naturalist to work upon—to endeavour to find out the nature and cause of the survival in a certain direction; in other words, to hunt down the selecting agent. Where ordinary observation has in so many cases failed, the newer methods appear to open out endless possibilities of attacking such problems. The student of bionomics will, as statistical data and their deductions accumulate, have definite information given as to what is going on in particular species, and it will be for him to approach the study of such species armed with specific questions awaiting answer in the field or laboratory. We venture to think that, far from any antagonism existing between the older and newer methods, the introduction of statistics in the Galtonian sense cannot but give a great impetus to observational work. It may be added that the periodical is really cosmopolitan, and the editors invite contributions in German, French or Italian, as well as in English. We cordially wish the new journal the success which it merits.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held as usual on St. Andrew's Day, November 30, when the annual report of the Council to the Fellows was presented. Among the subjects mentioned in this report is the proposal to establish a British Academy, which was discussed at a special meeting of the Society held in May last.

Reference is made by the Council to the subject of the tenure of office of the secretaries, which was recently raised again. A memorial "praying the President and Council to take into immediate consideration the advisability of limiting the tenure of office of any future treasurer or secretary," and also a memorial expressing the decided convictions of the memorialists that the change advocated by the preceding memorial would not be in the interests of the Society, were taken into consideration at the meeting of the Council on November 7. It was proposed, as a resolution, "That in the opinion of this Council it is desirable that the secretaries should not be so re-elected as to hold office for a period exceeding ten consecutive years, this resolution not to apply to the present holders of office," and, after considerable discussion and the consideration of various amendments, the resolution was carried.

As already announced, in consequence of his appointment as Principal of the University of London, Prof. Rücker has resigned his office as secretary, and is now succeeded by the distinguished mathematician and physicist, Dr. Joseph Larmor.

The address of the president referred to the scientific work of the Fellows and Foreign Members deceased since the former annual meeting, and a few investigations commenced or carried on in the course of the year. The work of this year's medallists was described as follows:—

COPLEY MEDAL.

Prof. J. Willard Gibbs, Foreign Member, R.S.

The Copley Medal is awarded to Prof. J. Willard Gibbs, a Foreign Member of this Society, for his contributions to mathematical physics.

Although Horstmann had demonstrated, between 1869 and 1873, the applicability of the mechanical theory of heat to the elucidation of the phenomena attending dissociation, J. Willard Gibbs was the first to apply the second law of thermodynamics to the exhaustive discussion of the relations between chemical, electrical and thermal energy and capacity for external work. His great contribution to this subject appeared in the *Transactions* of the Connecticut Academy in two parts, the first in 1875 and the second in 1878. In this paper, which opens with a discussion of the criteria of equilibrium and of stability as applying to a material system, the conditions of equilibrium prevailing in both homogeneous and heterogeneous systems of gaseous, liquid and solid materials are considered in a highly generalised form; and it is shown by Gibbs that Deville and Troost's experimental values of the density of nitrogen peroxide at different temperatures, and Playfair and Wanklyn's results obtained with mixtures of nitrogen peroxide and nitrogen, can be interpreted quantitatively with the aid of his fundamental gas equation.

The most important result of Gibbs's work, from a chemical standpoint, is the so-called "phase rule," the law which governs the general case of complete heterogeneous equilibrium. This law, which was developed theoretically, states that a system in complete heterogeneous equilibrium must be composed of at least n different molecular components if it consists of $n+1$ different phases.

The application of the phase rule has been repeatedly verified experimentally under a great variety of aspects. During the last few years the recognition of the law has led, amongst other important results, to a complete systematisation of our knowledge concerning dissolution of solid substances, the distribution of a solute between two immiscible solvents, and to the formation of double salts and of racemic, pseudo-racemic, non-racemic

and externally compensated substances. The phase rule has also been applied with complete success by van 't Hoff to the elucidation of the formation of oceanic salt deposits. In fact, Willard Gibbs's generalisation is applicable to all cases of reversible chemical interchange, and consequently to chemical change generally.

ROYAL MEDAL.

Prof. William Edward Ayrton, F.R.S.

A Royal Medal is given to Prof. William Edward Ayrton, F.R.S., for his contributions to electrical science.

The services rendered by Prof. Ayrton to science during the last twenty-seven years may be roughly grouped under two heads. He has carried out a large number of researches in pure physics, and he has taken a very prominent part in the development of the application of electricity to industry, which has been so remarkable a feature of the closing years of the nineteenth century. It is not here necessary to refer particularly to his researches, invention and inspiration under the second head. At all times he has been doing service under both heads. From 1873 to 1878, in Japan; from 1879 to 1884, at Finsbury; and from 1884 to the present time, at the Central College, Kensington, he has acted as professor of physics; he has arranged large laboratories, and through his own example in research he has inspired many students, who are now carrying out investigations of their own.

A large number of papers contributed, sometimes alone and sometimes in partnership with others, to the Royal Society *Proceedings* and *Transactions* and other scientific publications, while belonging to the second group above mentioned, have greatly assisted in pure physics.

It is not out of place to quote a published remark of the late Prof. Clerk Maxwell in reference to the work of Prof. Ayrton and a colleague in Japan, that they had moved the centre of gravity of electrical science greatly eastward.

ROYAL MEDAL.

Dr. William Thomas Blanford, F.R.S.

The other Royal Medal is conferred upon Dr. William Thomas Blanford, F.R.S., for his work in connection with the "Geographical Distribution of Animals."

Dr. W. T. Blanford received his scientific education at the Royal School of Mines, and, after special instruction in the methods of geological surveying under Prof. (afterwards Sir Andrew) Ramsay on the English Geological Survey, proceeded in 1855 to take up a post on the Geological Survey of India.

Between the years 1855 and 1868, when he was engaged in surveying different parts of India and Burma, he published a number of valuable papers on Indian geology, and upon malacology and other branches of natural history, based on observations made during his travels as a geological surveyor.

In 1868 he was appointed to accompany the expeditionary force under Lord Napier to Abyssinia in the capacity of naturalist, and his observations on the geology and fauna of the country are published in a number of communications to scientific journals and in his work, "Observations on the Geology and Zoology of Abyssinia," published in 1870.

Between 1868 and 1872, Dr. Blanford returned to his work on the Geological Survey of India, and as the result of his labours in Sind, Cutch, the Deccan and other parts of the country, a number of memoirs dealing with geology, malacology and ornithology were published by him. In 1872 he was selected to act as naturalist to the Persian Boundary Commission and the results of his observations appeared in a work, "Eastern Persia, vol. ii., Zoology and Geology," which was published in 1876.

Returning to India, he not only carried on the usual survey work, but, in conjunction with Mr. H. B. Medlicott, prepared the important "Manual of the Geology of India," 3 vols., 1879. In this work a most valuable summary of the geological observations which had been made upon all parts of the Indian Empire is given, with a discussion of the age and relationships of the formations of that vast district.

Since his return from India, in 1882, Dr. Blanford has been continuously engaged in zoological and geological researches. His memoirs on the rocks of India and Australia which exhibit glacial conditions, and on kindred subjects, have been most valuable contributions to geological science. Equally important have been the two addresses on "Geological Nomenclature" and "The Permanence or otherwise of Ocean Basins," which he delivered in his capacity of president of the Geological Society in 1889 and 1890. In the last-mentioned address he has laid down principles and established conclusions which have given a new aspect to the study of the geographical distribution of animals.

"The Fauna of India," published under the authority of the Secretary of State for India in Council (8 vols., concluded in 1898), was edited by Dr. Blanford, who has contributed three volumes on birds and mammals. This work has been most favourably received by the scientific public and is looked upon as the standard authority of Indian vertebrates. His contributions to this work constitute his special claim to a Royal Medal.

Dr. Blanford is one of the few men who are regarded as an authority on geology, palæontology and zoology, to each of which branches of science he has largely contributed.

DAVY MEDAL.

Prof. George Downing Liveing, F.R.S.

The Davy Medal is awarded to Prof. George Downing Liveing, F.R.S., for his contributions to spectroscopy.

Prof. Liveing's papers on spectroscopic subjects have been mainly published during the last quarter of a century in conjunction with Prof. Dewar, and have appeared for the most part in the *Proceedings* of the Royal Society. They make up a record of patient, accurate, conscientious labour, and, taken together, constitute one of the most valuable contributions to this department of chemical physics yet made by British workers.

SYLVESTER MEDAL.

Prof. Henri Poincaré, Foreign Member, R.S.

The Sylvester Medal, given this year for the first time, is awarded to Prof. Henri Poincaré, a Foreign Member of this Society, for his many and important contributions to mathematical science.

Prof. Henri Poincaré's mathematical writings display very great originality, independence of thought and far-sightedness. The number of the memoirs and works which he has published is extraordinary, and the wide range of subjects in pure mathematics and its applications to astronomy and physics which they cover is equally remarkable. The bond of unity which connects his investigations is that nearly all have a more or less intimate connection with the study of differential equations. He has dealt with the theories of linear differential equations, of ordinary non-linear differential equations and of partial differential equations, with striking results in each theory; and each is associated with a department of his other important researches.

In the theory of linear differential equations, Fuchs had called attention to the substitutions by which different particular integrals are interchanged at the critical points. The substitutions form a group, and (at any rate when the equation is of the second order) there exist automorphic functions which are unchanged by the operations of the group. M. Poincaré has constructed these functions and shown how by means of them a complete integration of the linear differential equation can be effected (*Acta Mathematica*, t. iv.). He has devoted five classical memoirs (*Acta Mathematica*, i., iii., iv., v.) to a profound study of the automorphic functions and Fuchsian and Kleinian groups. Closely related to the same study are his delicate researches as to the topology of loci in space of n dimensions, and a number of contributions to the theory of algebraic functions.

In the theory of ordinary differential equations (not linear) he has introduced a new method of dealing with the question of the existence of a solution, and has shown how various methods of approximating to a solution may be utilised for solving the problem which gives rise to the differential equation. This lies at the root of his investigations in connection with the equations of dynamics and the special problem of gravitational astronomy —that of n bodies. He has shown that G. W. Hill's periodic solution of the problem of three bodies is one of an infinite system. M. Poincaré has also discussed from the point of view of modern analysis the methods of solution in periodic series which are associated with the name of Laplace and with the problem of the stability of the solar system, and has been led to give the first complete theory of series of the kind now called "asymptotic" and to point out their uses in analysis.

Mathematical physics requires the investigation of certain

partial differential equations, and the problem arises to develop a formula from which the solution, subject to boundary conditions, can be calculated. The problem can in any case be reduced to the discovery of what is now called a Green's function. To Poincaré is due perhaps the most feasible means yet devised for arriving at these functions. A general analytical theory has also been given by him of a somewhat different problem, required in theories of vibration and electrical oscillation. The diffraction of light has also been discussed by him in an elaborate memoir.

He has besides enriched pure mathematics with researches in the theory of numbers and on double integrals. In applied mathematics he has obtained remarkable results with regard to the figures which can be assumed by rotating fluid. To dynamical astronomy he has contributed, not only memoirs, but a monumental work in three volumes—"Les Méthodes Nouvelles de la Mécanique Céleste."

Finally, allusion may be made to the services which M. Poincaré has rendered to a number of branches of mathematical physics, by critical presentation of the work of others in published courses of lectures.

The officers and Council elected for the ensuing year were the Fellows whose names have already been given (p. 34), with two others to supersede two Fellows who found themselves unable to serve (p. 85).

On the evening of Saturday, the Fellows and their friends dined together in the Whitehall Rooms, when, to quote the *Times* report, "no Cabinet Minister and only one ex-Minister—Mr. John Morley—was present. Thus the calm discourse of the men of research was undisturbed by even the suggestion of political strife." It might also have been added that thus do Ministers of State manifest their indifference to associations having no political significance.

NOTES.

WE regret to announce the death of Sir William MacCormac, the distinguished president of the Royal College of Surgeons.

PROF. YVES DELAGE has been elected a member of the section of anatomy and zoology of the Paris Academy of Sciences in succession to the late Prof. Lacaze-Duthiers. Prof. Gouy, professor of physics in the University of Lyons, has been elected a correspondant of the Academy in succession to the late Prof. Raoult.

IN response to appeals made by the Dover Chamber of Commerce to the Trinity House to place wireless telegraphy installations on the lightships in this part of the English Channel, an intimation has been received by the Chamber that the matter is under consideration by a special inter-departmental committee.

THE National Antarctic Exploration ship *Discovery* arrived at Lyttelton on Nov. 23. The ship has been dry-docked for caulking, having sprung a leak, though not a serious one.

MR. JONATHAN HUTCHINSON, F.R.S., is about to proceed to South Africa with the view to study the cause of leprosy. He will proceed to Robben Island, and will probably go on to Natal and Basutoland. His object is especially to obtain facts as to the use of dried and badly salted fish. Leprosy is a comparatively new disease in Cape Colony, and quite so in Natal and Basutoland. Thus these districts offer exceptional opportunities for ascertaining its cause.

THE Berlin correspondent of the *Times* reports that the German Imperial Estimates include the sum of 150,000 marks (7500*l.*) to be devoted to the prevention of tuberculosis and to the investigation of that disease. The sum will be largely applied to the promotion of research with the object of settling the question of the identity of tuberculosis in human beings and in animals. For the promotion of markets for agricultural produce and for the support of scientific, technical and kindred undertakings in the interest of agriculture a sum of 90,000 marks will be demanded, as against 50,000 marks last year.

EX-GOVERNOR EYRE, who died on Saturday at the age of eighty-six, was less known perhaps for his geographical work than for his action in connection with the disturbances in Jamaica thirty-six years ago. Yet he was an intrepid explorer, and in 1843 he received the Founder's Medal of the Roya Geographical Society for his explorations in Australia. He crossed the Australian continent overland from Sydney in the east to Swan River in the west, and investigated the then unknown shore of the Great Australian Bight between King George's Sound in Western Australia and Port Lincoln in South Australia. In 1845 he published the results of his explorations in a work entitled "Discoveries in Central Australia."

A SPECIAL expedition, under Dr. Charles Balfour Stewart, has just been sent by the Liverpool School of Tropical Medicine to the Gold Coast and to the gold-mining districts of that colony, to conduct a series of operations there with a view to improve the conditions of health and sanitation. Dr. Stewart was to have sailed for Cape Coast Castle on November 16, but his departure had to be delayed as the municipal authorities of Liverpool requisitioned his services to deal with an outbreak of plague in the city. The lines on which Dr. Balfour Stewart will proceed will be similar, so far as possible, to those now being followed by the Sierra Leone expedition of the Liverpoo School under Dr. Logan Taylor.

THE death is announced of Mr. Samuel Rowles Pattison, who for some years was a member of Council of the Geological Society and its honorary legal adviser. In early life he resided at Launceston, where he made a collection of fossils from the limestone of Petherwin, and assisted by his local knowledge both De la Beche and John Phillips. He contributed papers on local geology to the *Transactions* of the Royal Geological Society of Cornwall and the Royal Institution of Cornwall from 1840 to 1860; and in the *Quarterly Journal* of the Geological Society of London he recorded the occurrence of auriferous quartz-rock in north Cornwall. In 1858 he published a work entitled "The Earth and the Word; or Geology for Bible Students." Mr. Pattison, who had attained the ripe age of ninety-two, died on November 27.

THE results of an analysis of the returns relating to the outbreak of small-pox in London are given in an article in Saturday's *Times*. There have been 349 completed cases, that is, cases which have ended in death or recovery, since May last. Of these 349 patients 181 were males and 168 females. The number of deaths was 116, and the rate of mortality was three times as great among the unvaccinated as among the vaccinated. The following points brought out by the classification of the cases are instructive:—(1) All the cases under five were unvaccinated, and out of 23 there were 19 deaths; (2) all the children under ten were unvaccinated except one, and out of 42 there were 29 deaths, all the deaths being of unvaccinated children; (3) out of a total of 81 children under fifteen years 57 were unvaccinated and 38 died. Only one death out of the 38 took place in a vaccinated child; of 24 vaccinated children 23 recovered. These facts show the fatality of the disease among young children and the protection afforded by primary vaccination against attack in the first instance and against a fatal result in the second. The protection diminishes progressively after childhood, but the rate of mortality remains enormously higher among the unvaccinated in every age period.

THE results of several series of experimental work in connection with the cultivation of hops were described at the conference of hop-growers held at the South-Eastern Agricultural College last week. The object of the meeting was to receive and discuss the reports of the various experiments upon hops that have been carried out by the College during the past

season. These experiments have in many cases been going on continuously on the same plots since 1895, so that the results are beginning to show a measure of consistency that is not immediately attainable in field trials. Training experiments at Wye are favourable, on the whole, to the systems of wide planting and broad alleys. The umbrella system of training has generally given the maximum weight per acre, but has various disadvantages compared with the Butcher system. Cutting the bine at picking time, as is done when hops are grown on poles or on some wire systems, is found to result in a considerable loss of material to the hop plant, and weakening and loss of crop in the succeeding year. Stripping off the lower leaves and laterals is found to be harmful in seasons of short growth and without effect when the plant is vigorous. Cultivation experiments at Goudhurst, where a plot has now carried a full crop for seven years though without any cultivation beyond surface hoeing, aroused considerable discussion; the trial is to be extended to other soils. Manurial experiments have been carried out on various soils in Kent and Surrey and deal chiefly with the use of mineral manures; the soil is shown to be the main factor in the results attained, especially in the cases where the cultivation has been extended from the typical hoplands to sandy or clay soils.

THE third number of vol. ii. of the *West Indian Bulletin* just received from Barbados, contains a good deal of useful information relating mainly to cacao and sugar-canes. Mr. Maxwell-Lefroy, entomologist to the Imperial Agricultural Department, has visited the island of Grenada to investigate the prevalence of an insect pest known as "thrips," affecting the leaves and pods of the cacao, and apparently to a less extent the leaves of cashew, guava and Liberian coffee. The insect is found also on cacao in the islands of St. Vincent, St. Lucia and Dominica, but is not known in any other part of the world. Thus far its depredations have not been of a very serious character, and to prevent its becoming a greater plague advice is given to the planters as to the methods which should be adopted to suppress it. Mr. Howard, the mycologist, deals with the fungoid diseases of cacao in the West Indies, summarising the results obtained by the Department in recent investigations. The subject is fully treated in three divisions—pod diseases, stem diseases and root disease. Mr. William G. Freeman, the technical assistant, in a note on the formation of cane-sugar in the sugar-cane, endeavours to give some idea of the possible sequence of events, but more investigation is necessary to clear up many doubtful points—we require to know, for instance, the first product of assimilation and the true relationship to each other of glucose and cane-sugar. Amongst other contributions are Sir W. T. Thiselton-Dyer's note on sugar-cane disease, and Mr. Noël Deerr's article on the distribution of the constituents of the sugar-cane in a Demerara factory and their utilisation as manure. There is an illustrated article on bud variation in the sugar-cane. Information has been collected from the various islands showing the planting and crop seasons of the sugar-cane. A full description of Barbados sour-grass, *Andropogon pertusus*, is given; and the desirability of introducing insectivorous birds from other countries to prey on the insect pests which cause so much destruction in the West Indies is discussed, but the conclusion arrived at seems to be in favour of encouraging the propagation of the local Barbados blackbird and to keep out the East Indian myna or starling, fearing the latter would become a worse pest than the insects.

A PRELIMINARY report of the international balloon ascents of June 13 has just been received. The places from which the ascents were made were Trappes (Paris), Chalais-Meudon, Strassburg, Berlin, Vienna, Pavlovsk (St. Petersburg), Moscow and Bath. In six cases the unmanned balloons were lost, or the records are not forthcoming. The greatest altitude, 14,800 metres, was attained from Trappes, where the lowest temperature, −51°·4 C., was recorded. The ascent took place about 8h. a.m.; temperature at starting, 10°·4, at 6090 m., −25°, at 10,900 m., −50°. At Strassburg the unmanned balloon ascended at 3h. 46 m. p.m., temperature 16°, and went through a thunderstorm cloud; at 2800 m. the temperature was 0°, at 4500 m. −10°, at 5400 m. −15°; the greatest height reached was 5700 m., temperature −17°. Another balloon which ascended about the same time reached an altitude of 10,400 m. and the lowest temperature recorded was −49°·9. One of the balloons sent up from Berlin reached a height of 9315 m., temperature −43°·5. From Vienna an unmanned balloon left the earth at 8h. a.m., temperature 22°; at 5000 m. −20°, and at 8900 m. −63° were recorded. Several manned balloons took part in the experiments; one of two from Vienna, carrying Archduke Leopold Salvator and Captain Hinterstoisser, ascended to 3500 metres, where a temperature of −4° was recorded.

MR. C. V. DRYSDALE communicated to the Institution of Electrical Engineers last week a description of a new form of permeameter for testing the magnetic qualities of iron and steel in bulk. A special form of hollow drill is used to drill a hole $\frac{5}{8}$ inch deep in the material to be tested; this hole has its upper part conical, and the small central pin left standing is $\frac{1}{10}$ inch in diameter. Into this hole fits a soft iron plug on the lower part of which are wound the magnetising and testing coils. There is thus formed a miniature permeameter in which nearly the whole of the magnetic circuit is of the material under test. By connecting the coils in the plug with suitably graduated instruments the permeability, retentivity and hysteresis may be very easily tested. Curves and figures which were published showed that the instrument gave very consistent results, although, as was pointed out in the discussion, they did not agree as well as they might with the values usually obtained by other permeameters. But the simplicity of the apparatus and the ease with which a test can be obtained (if, that is, the drills can be made to act with uniform accuracy) should give it considerable commercial value. The dynamo manufacturer requires chiefly a rough guide to the permeability of the casting he is going to use and does not need very rigid scientific accuracy, and such a guide Mr. Drysdale's instrument should be able to provide. In fact, any method which really only tests a very small portion of the bulk, whether *in situ*, as in this case, or after it has been cut off, can never be thoroughly satisfactory.

PROF. LEBEDEW, of Moscow University, describes in Drude's *Annalen der Physik* for November, 1901, a research by means of which he has succeeded in demonstrating experimentally the pressure of light. A translation of his paper is now appearing in the *Electrician*. It followed as a consequence of Maxwell's theory that the combined effect of the electrostatic and electrokinetic stresses is a pressure in the direction of the propagation of the wave numerically equal to the energy in unit volume, and Maxwell pointed out that "the concentrated rays of the electric lamp falling on a thin metallic disc, delicately suspended in a vacuum, might perhaps produce an observable mechanical effect." It was this effect that Sir William Crookes was thought to have obtained in his radiometer, but the magnitude proved many thousand times too great. Prof. Lebedew eliminated the radiometer action by using a large bulb with high exhaustion and by excluding rays capable of heating the tube walls. The radiometer vanes were of very thin aluminium foil suspended by a glass fibre, and the source of light the electric arc. The results obtained agree with the theoretical results of Maxwell within 10 per cent., and show that the pressure is directly proportional to the energy of the incident light and independent of the colour.

A CONCISE handbook of the geology of the city of New York has been published by Mr. L. P. Gratacap, of the American Museum of Natural History.

THE periodic variations of glaciers are dealt with by Dr. S. Finsterwalder and M. E. Muret in the sixth report of the International Commission on Glaciers (*Arch. Sc. Phys. et Nat.* Genève, tome xii., 1901).

"ICE CAVES and Frozen Wells as Meteorological Phenomena" is the title of a paper by Mr. H. H. Kimball (*Monthly Weather Review*, August 1901). The author's observations were made in New York co. and Vermont, and he concludes that the phenomena are due to the cold air of winter circulating to unusual depths below the surface and freezing the small quantity of water with which it comes in contact. The ice may not entirely disappear during the following summer, but continue under certain conditions to accumulate for ages.

IN the Memoirs of the Geological Survey of India (vol. xxxi. part ii., 1901) there is a geological sketch of the Baluchistan Desert and part of eastern Persia, by Mr. E. Vredenburg. The rocks comprise marine strata ranging in age from Upper Cretaceous to Upper Eocene. Interbedded with them is a large proportion of volcanic rocks, and these, together with numerous igneous intrusions, form the chief hill masses. Considerable areas are occupied by Siwalik strata, land deposits of Miocene age, which consist of conglomerates, friable sandstones, and clays frequently white or brightly coloured in various tints of pale terra-cotta, ochre or green. Much of the low ground is concealed by modern alluvium and sand dunes. Except in the unusual event of a storm the plains are absolutely dry, and when such an occurrence takes place the flood seldom lasts more than an hour. Then the water rushes through a network of irregular and ever-shifting furrows, rolling along with it large boulders which rattle loudly as they come into collision. These floods by their suddenness constitute a source of danger to the flocks, especially to sheep and goats, which may be carried away if not driven off in time by the shepherds. In the western portion of the country examined there are several recent volcanoes, one of which still shows signs of activity.

THE artesian waters of Australia were dealt with by Mr. J. P. Thomson in a paper read at a recent meeting of the Royal Geographical Society of Australia. Although the whole of the Australian colonies have taken an active part in the somewhat minute and altogether elaborate search for artesian water, it is to Queensland that the greatest credit is due for having discovered the existence of an unlimited and practically inexhaustible supply in the lower cretaceous formation that underlies the vast rolling downs of the western portion of that State. Several of the inland towns and many parts of the western district are now watered by numerous artesian wells or bores. In some remarks upon the subject, the president of the Society, Sir Hugh Nelson, pointed out that up to the present time the amount of artesian water brought to the surface at the bores has had very little effect as an irrigating agent upon the great areas of land in the west during seasons of drought. This water is valuable for drinking purposes for stock, but stock cannot exist upon water alone—they require herbage, and the supply of water is not plentiful enough to irrigate the runs. The Hon. A. C. Gregory also explained that artesian water contains a small percentage of saline matter, and while it might be used for irrigating small areas of cultivation the saline properties of the water have the reverse of a beneficial effect upon the land when the water is used to irrigate large tracts of country.

WE have received a copy of "A Catalogue of Crustacea and Pycnogonida in the Museum of University College, Dundee," by Prof. d'Arcy W. Thompson. The list is a long one.

THE Egyptian Government has just issued a series of "Notes for Travellers and Sportsmen in the Sudan." These give full information with regard to the game of the country and the conditions under which it may be killed. The regulations for the protection of the rarer species seem well calculated to attain the end in view—at least for a time.

THE nesting and other habits of one of the North American cat-fishes of the genus Amiurus forms the subject of a paper, by Mr. A. C. Eycleshymer, in the *American Naturalist* for November. "Although repeated efforts were made," writes the author, "to find the nests, they were unsuccessful until June 8, 1896, when three nests were found in Fowler Lake, Wisconsin. Two of these were in pieces of stovepipe, the third in an old pail. The nests were in clear water, near a bold rocky shore, and at a depth of four or five feet; all contained embryos, and each was guarded by a parent fish—which one I did not ascertain."

THE latest issue of the *Zeitschrift für Wissenschaftliche Zoologie* (vol. lxx. pt. iii.) contains two papers, one, by Dr. R. Hesse, on the eyes of arthropods (being the seventh of a series on the visual organs of invertebrates), and the second, by Herr C. Rabl, on the origin of limbs. In the latter memoir much attention is devoted to the question whether fins, as Gegenbaur thought, are derived from modified gill-arches, or whether, as suggested by Balfour and Thacher, from lateral folds, the author favouring the latter view. The diagrams illustrating the various modifications of carpal and tarsal structure in the lower vertebrates are especially interesting.

TO the November number of the *American Naturalist* Mr. H. L. Osborne communicates some interesting notes on axolotls from Colorado and Dakota. Two kinds of metamorphosis occur during the passage of these creatures from an aquatic to a terrestrial existence, first of all in the development of the limbs and lungs, the alteration of the circulatory system and the maturation of the reproductive organs. But there are also secondary changes, which may occur either early or late in life. In some districts axolotls pass into the adult amblystoma state when quite small; but in Mexico the secondary changes never take place at all, so that the animal, although adult in other respects, remains in the aquatic condition throughout life.

AN important paper in the November issue of the *Quarterly Journal of Microscopical Science* is one by Mr. E. S. Goodrich on the pelvic girdle and fins of the "fringe-finned ganoid" fish Eusthenopteron. The specimen on which the communication is based is from the Devonian of Canada, and is preserved in the British Museum. It is remarkable as being the only known example among the numerous remains of the extinct representatives of the group in question in which the pelvis and fins are preserved in a complete state and showing their natural relations to one another. Although the structure of the fin-rays shows a curious approximation to the type of the more specialised modern bony fishes, in other respects the pelvic fins of this fish show signs of being derived from a type allied to that which persists in the Queensland lung-fish (Ceratodus). Another article in the same journal, by Mr. E. P. Allis, deals with certain parts of the anatomy of the small shark known as *Mustelus laevis*.

THE *Transactions* of the New Zealand Institute for 1900 contain a large number of papers on the zoology of the colony, as well as others connected with acclimatisation and stock-breeding. Among the former, reference may be made to Prof. Benham's description of the New Zealand lancelet, of which only two examples appear to be known. This form is now referred to the genus Heteropleuron, the commonest type of the group in the southern hemisphere, under the name of *H. hectori*. In

two other communications the same writer discusses the New Zealand earthworms, describing three new species, under as many generic heads. Prof. Dendy and Miss Olliver jointly describe a new freshwater leech of the genus Glossiphonia, while the former contributes a fourth paper on the land planarians of the colony.

THE acclimatisation and variation of Salmonidæ in New Zealand form the subject of a paper in the *Transactions* of the New Zealand Institute for 1900 by Mr. A. J. Rutherfurd, in which it is concluded that greater success is likely to attend the introduction of the north Pacific salmonoids than that of *Salmo salar*, which is a more delicate fish, unlikely to find what it requires in an ocean so far removed from its native habitat. In regard to trout, the author is of opinion that "whatever variety we liberate of the ordinary species of trout, it will develop into a *Salmo novae-zealandiae*, suited to the water in which it is liberated, and corresponding with trout in similar localities in the Northern Hemisphere more closely than with the varieties found in the more northern latitudes of our mother-country." Considerable interest also attaches to a paper by Mr. T. White on breeding black merinoes, of which there are now several flocks in the colony. Although the wool does not fetch so high a price as the best selected white it is really more valuable, as the price is the same for the whole fleece.

A CIRCULAR which we have just received from Messrs. Hirschberg and Oestergaard, Berlin, provides us with another example of German enterprise. This firm has produced a large wall map of the British Isles and of the world, showing the British colonies in a distinctive colour, and special offers are being made to English newspapers to take up the map and sell it to their readers. The map is 53 in. by 42 and is printed in twelve colours. In a space left at the top the title of the newspaper adopting the map, and other particulars of local interest, will be inserted as desired. As a number of newspapers have taken up the map there is apparently no objection to its German origin. But how is it that our geographical publishers cannot make similar arrangements with newspapers, and so prevent, in a sense, the war from being carried into our own country? It certainly seems strange that Germany should find it worth while to supply us with cheap maps of the British Isles and the Empire.

THE "Year Book of the Scientific and Learned Societies" (London: C. Griffin and Co., Ltd.) is a very handy guide to organisations existing in the British Isles for the promotion of knowledge. The societies and other institutions are arranged in fourteen different departments, according to their objects, and particulars are given as to officers, meetings, conditions of membership, and publications of each. In addition, lists are given of papers read before each society from January, 1900, to June of the present year. The reason why the papers read during eighteen months are catalogued instead of those read in a calendar year is that it is intended in future to make the Year Book correspond as closely as possible with the sessional year of the societies dealt with in it. Subsequent volumes will therefore record the papers read before each society between September and June, and they will be published as early as possible in the succeeding session. This change will be an additional convenience to those who use the Year Book as a manual of ready reference or a general review of Great Britain's annual contributions to scientific knowledge.

THE work of John Mayow, a pupil of Robert Boyle, was touched upon by Dr. J. B. Cohen, in an address recently delivered before the Yorkshire College Scientific Society. Mayow was certainly a genius, and some of his observations are remarkable for their shrewdness and depth, but they have often been misrepresented, and Dr. Cohen gives some interpretations of them which should interest students of the history of chemistry. His treatise on combustion was completed before the birth of the phlogiston theory, and was revived a century later, after Priestley had discovered oxygen, and the phlogiston theory was breaking down. Referring to Mayow's experiments on hydrogen and nitric oxide, Dr. Cohen remarks, "it must suffice to say that he anticipated Priestley in recognising both these as distinct kinds of gases, differing from, but possessing the same elasticity as air. Although Priestley's view of the composition of dephlogisticated air has much in common with that of Mayow's nitro-aërial particles, there is plenty of evidence to show that Priestley's ideas were formed quite independently. It must be admitted, however, that they show little advance on those of a whole century before."

THE recent work of M. Moissan on the properties of pure calcium has shown that the description of this element current in the text-books was by no means an accurate one, and from the work of M. Guntz, published in the current number of the *Comptes rendus*, it would appear that the properties of pure barium also differ considerably from those hitherto assigned to it. The starting point of the work is barium amalgam, and by the electrolysis of a saturated solution of barium chloride with a mercury kathode it would appear to be quite easy to prepare several kilograms of a 3 per cent. barium amalgam. It is the separation of the mercury from this amalgam which has proved to be such a difficult matter. M. Maquenne, for instance, who attempted to distil off the mercury, was quite unable to obtain a coherent ingot of barium in this way. M. Guntz has found that the secret of success in this experiment is to apply the heating gradually; the amalgam is placed in an iron boat in a wide porcelain tube and the tube heated by a coil of fine platinum wire, brasqued by a protecting coating of alumina and magnesia. By means of this electric furnace it has been found possible to raise the temperature as slowly as 200° C. per hour, and finally to maintain the tube, 50 mm. in diameter and 300 mm. long, at 1200° to 1300° C., with an expenditure of 600 to 700 watts. Working in this way a good yield of pure barium has been obtained at 1000° C. The barium thus obtained when freshly cut has a white silvery lustre; it is soft, a little harder than lead, and is extremely oxidisable in the air, often catching fire when attempting to remove it from the boat by means of a hard body. It resembles lithium and calcium in dissolving in liquid ammonia, and attacks easily water, alcohol and even an alcoholic solution of baryta.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Dr. A. E. Neale; two Short-eared Owls (*Asio brachyotus*), one Short-eared Owl (*Asio brachyotus*), European, presented respectively by Mr. W. Jamrach and Mr. C. W. Burnett; a Variegated Sheldrake (*Tadorna variegata*) from New Zealand, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEW STAR IN PERSEUS.—Sir Norman Lockyer recently communicated to the Royal Society some further observations of the new star in Perseus made at the Solar Physics Observatory in continuation of the last previously recorded (Roy. Soc. *Proc.*, vol. lxviii. p. 399). In the present paper, which brings the information up to the end of September, it is first pointed out that the short period light variations have ceased and that the Nova was gradually becoming fainter, reaching about magnitude 6·7. In the visual spectrum the nebular line at wave-length 5007 was the strongest. Photographs of the spectrum showed that since last April a great change has taken place. The lines then were very broad and ill defined, but are now much narrower with better defined edges. The lines of hydrogen, which were the strongest in the spectrum have become comparatively very

weak. Other lines have made their appearance, the strongest of which are 3868 and 3970, 4364 and 4720. The first is an unknown line strong in the spectra of planetary nebulæ, while the other three are of unknown origin. It is suggested that the second line (3970A) is not the line of hydrogen at Hε, as the other hydrogen lines in the spectrum are so weak. There is, further, a new line in the ultra-violet at wave-length 342 (about), which Gothard has independently recorded. It is interesting to note that the new gas lines show a structure somewhat similar to that of the hydrogen lines in earlier photographs. The enhanced lines of iron, magnesium, &c., which were such a conspicuous feature of the first photographs, have entirely disappeared, and the probability is that the bright lines now, other than hydrogen and helium, belong to gases the terrestrial equivalents of which have not been found.

VARIATION OF LATITUDE.—Prof. S. C. Chandler has made an exhaustive examination of the old records obtained with the reflex zenith tube at Greenwich from 1852–82, which were abandoned as being affected with undiscoverable sources of instrumental error, and finds that for the periods providing continuous measures throughout the year they yield most valuable data for the determination of latitude variation, and that this anomaly, unknown at the time, was most probably the cause of the want of agreement among the observations. The two periods yielding continuous values were 1857–63 and 1864–70 (*Astronomical Journal*, vol. xxii., No. 511.)

DETERMINATION OF THE ELEVATION OF METEORS.—During the rather brilliant display of Perseids in August last a series of successful experiments was made by the observers at Juvisy Observatory to determine the heights of as many meteors as possible. Two stations, Juvisy and Croix-de-Berny (Antony), were chosen at a distance of 9·200 km. The number of meteors registered at both stations was 21, of which 8 fulfilled all the necessary conditions for the determination, and a table is given showing their calculated heights of appearance and disappearance, and also the resulting length of trajectory. The lowest record is 15 km. and the highest 119 km. (*Bulletin de la Société Astronomique de France*, November 1901.)

MERIDIAN OBSERVATIONS AT HARVARD COLLEGE OBSERVATORY.—In a separately published portion of vol. xli. of the *Annals of Harvard College Observatory* (No. 7, pp. 189–211) Mr. A. Searle gives an account of a series of special investigations which have been in progress with the hope of eliminating several systematic errors in the transit observations. It was thought that these might be due to the employment of ruled glass plates instead of spider threads, and for a time the latter have been substituted for trial. The result showed that the change produced no important difference in the discrepancies referred to. Personal equation with respect to magnitude was noticeable in both right ascension and declination when the transits were taken over inclined lines, as was the case with the ruled glass plates formerly used.

LENGTH OF THE TERRESTRIAL DAY.—Mr. R. S. Woodward has been investigating the extent to which the secular cooling of the earth and the fall of meteoric dust may affect the length of the terrestrial day. Attention is first drawn to the conclusion of Laplace that the day has not changed appreciably owing to secular cooling during the past 2000 years, but this was on the assumption that the earth is in the last stages of cooling. This the present author thinks an unnecessary and doubtful restriction, and proceeds, using the other conditions identical with those of Laplace, to develop a method of determining the effect on the length of day of the cubical contraction of the earth during any portion of, or during the entire history of, the process of secular cooling.

It is suggested that, contrary to the views of Laplace, Fourier and Poisson, the dissipation of the internal heat of the earth is not controlled by the atmosphere and oceans, but escapes as if they did not exist.

The main conclusion is that in the entire history of secular cooling of the earth the day may be shortened from this cause by as much as 6 per cent. of its original length. With respect to a definite time variation, it is concluded that the length of the day will not change, or has not changed, as the case may be, by so much as half a second in the first ten million years after the initial epoch.

The concluding portion of the paper deals with the effect of accumulations of meteoric dust. The distribution is assumed as uniform over the surface. Taking Newton's estimate of the number of meteorites falling daily, it is calculated that at least a million million years would elapse before a change of a quarter of a second would be produced. The effect of secular cooling is thus considerably more than that of meteoric accumulations. (*Astronomical Journal*, vol. xxi, No. 502).

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE Section of Physiology was presided over by Prof. McKendrick, F.R.S., and the place of meeting was Prof. McKendrick's laboratory at the University. Despite the near approach of the date of the fifth triennial International meeting of Physiologists held at Turin in September, the Section was well attended by working physiologists, and the audiences were often large. Profs. Schäfer and Sherrington were vice-presidents, and amongst others contributing to the meetings were Sir Michael Foster, Sir John Sanderson, Dr. Theodore Beer, Dr. Brodie, Miss F. Buchanan, Dr. Burch, Prof. Gotch, Dr. A. A. Gray, Dr. Edridge Green, Prof. Marcus Hartog, Dr. Kennedy, Dr. Myers, Dr. Noel Paton, Prof. Waymouth Reid, Dr. W. H. R. Rivers, Prof. W. H. Thompson, and Dr. J. A. Wanklyn.

The proceedings of the Section commenced with the president's address. Prof. McKendrick took for his theme the relation of physical and chemical structure as understood at present to our conception of the structure of living matter. The president commenced by pointing to the progress which had been made by physiology in the quarter of a century that had elapsed since the previous meeting at Glasgow. Physiology in its progress had proven itself a living and logical inductive science grappling successfully with its problems by help of the same laws that physics and chemistry apply to non-living matter and its phenomena. In this respect it contrasted strikingly with subjects, *e.g.* human anatomy, which had been closely associated with it formerly in educational curricula.

Physiology had in the last quarter of the century proved fruitful of discovery to an astonishing extent. Many of its discoveries were of high practical value to medicine as well as of theoretical value. It had struck deep into the soil, acquiring many new data of extreme accuracy and obtaining much profounder insight in the concatenations of the machinery of life. The phenomena of muscular contraction—that prime event in biodynamics,—the process of secretion by gland cells, the mutual synergy of organs as illustrated by internal secretion, the functional architecture of the nervous system, the mechanics of rejuvenescence of protoplasm by sexual recombination (fertilisation), all these branches of the physiological tree of knowledge had, under the cultivation of the last five and twenty years, grown vastly in extent and yielded blossom and invaluable fruit. Facts more accurate and theories more profound had drawn their science closer to the elder sister sciences of more exact measurement and at the same time had created, it must be admitted, a gap between it and subjects with which it had formerly been usually associated in teaching. It had widened the educational field and educational worth of physiology, releasing it from former restriction to narrower technical applications. Save in mathematics, knowledge cannot be absolute in any domain of natural science. Physiology shared with the sister sciences their birthright of problems that were, to speak in paradox, the more insoluble the further one progressed toward their solution.

The animal body—the human body—was a machine of high complexity, constituted of many interrelated parts, called organs, the "simple" tissues and the "compound" tissues. A number of its phenomena had indubitably received their lasting explanation; but the difficulty of examining the machinery of living matter while still in living action was extreme. The first step of the chemist's analysis was to kill the substance; yet his goal was analysis of matter still alive. A number of thoughtful physiologists had returned in recent years to study of the unit of physiological structure, the cell. For the study of the phenomena of life an object more suitable than the undifferentiated single independently living cell was in many cases a simple tissue composed of numbers of such cells associated and highly differentiated, but all differentiated in the same way one as another. Hence the tendency of the modern physiologist to examine the powers and reactions of the simple tissues rather than of unicellular organisms such as amœba. It must be admitted, however, that in spite of all their labour in many respects their knowledge had not yet reached far. For

instance, the visible details of structure revealed in the cell by the most perfect modern microscopes in collaboration with all the elaborate technique of modern histology seemed to bring us in no perceptible degree nearer towards an explanation of the chemical and physical construction of the cell. But if the matter were considered fully it became evident that the phenomena of life depend on changes occurring in the interactions of particles of matter far too small even to be seen by the strongest magnification yet obtainable by microscopes.

The physicist and chemist had not been content, it was pointed out, with the investigation of large masses of dead matter. To explain many of the phenomena they met with they had had recourse to the conceptions of molecules and atoms and to the formulation of laws that regulate the movements of these units almost infinitely small. The conception of the characters and dimensions of the molecules of *living* matter had occupied certain of the astutest physicists. Clerk Maxwell had placed before the physiologist a curious dilemma. Either the germ could not be homogeneous, developing as it does into a complex being with its hundred thousand characteristics, or if structurally diverse it is so small that its number of parts is insufficient to give a basis for the development of all the characteristics inherent in and developed by it as it expands into the adult creature. Only another supposition was postulable, namely that the germ was not a material system entirely; the adoption of that last supposition was, of course, equivalent to resigning the problem as inaccessible to any method obtaining in natural science.

If, however, in the light of twenty-five years of additional knowledge since the time of Clerk Maxwell the problem were reexamined we were not led necessarily to the dilemma he propounded. A quarter of a century ago it seemed to so competent an inquirer as he that the number of organic molecules in the fertilised ovum would be too few to account for the transmission of hereditary peculiarities. It then seemed that the molecules would not amount to a million in number. But to-day, Prof. McKendrick urged, it was reasonable from existing data to suppose that the germinal vesicle might contain a million of millions of organic molecules. Complex arrangements of these molecules suited for the development of all the parts of a highly complicated organism might satisfy all the demands of the theory of heredity. Doubtless the germ was a material system through and through. The conception of the physicist was that molecules were in various states of movement; and the thinkers were striving toward a kinetic theory of molecules and of atoms of solid matter which might be as fruitful as the kinetic theory of gases. There were motions atomic and molecular. It was conceivable that the peculiarities of vital action might be determined by the kind of motion that took place in the molecules of what we call living matter. It might be different in kind from some of the motions dealt with by physicists. Life is continually being created from non-living material; such, at least, is the existing view of growth by the assimilation of food. The creation of living matter out of non-living may be the transmission to the dead matter of molecular motions which are *sui generis* in form.

Sir John Burdon Sanderson opened the ordinary work of the Section by communicating a paper on the use of the telephone for investigating the rhythmic phenomena of muscles. The communication was largely based on the recent researches of Miss Florence Buchanan. Sir John explained that it was well known that violent contractions of muscle are sometimes obviously rhythmical. The muscular rhythm he should deal with was of a different kind and seat of production to that of violent willed action. The latter had its origin in the rhythmic discharge of nerve-centres. But the muscles themselves seemed to respond rhythmically, not continuously, to even continuous excitation. Their rate of rhythm was of much higher frequency than that of the nervous system; it amounted to repetitions amounting to about 100 per second. The rhythmic variation in the contracting elements of the muscle was variation of, amongst other states, that of electrical tension. Wedenskii, of St. Petersburg, had used the telephone for investigation of this condition of the muscle. A certain note might be low, *e.g.*, A in the bass clef, and if they applied stimuli to the muscle at something like the rate of that pitch they could force the muscle to harmonise. If the stimuli were regulated to G instead of A it would correspond with G, if with B instead of A, with B. But if the frequency were increased to much higher the muscle showed the same response as before—they had always about the same note. The muscle had, therefore, within limits a period of phasic activity of its own.

The next communication made, on behalf of Dr. A. S. Grünbaum (Liverpool) and himself, by Prof. Sherrington (Liverpool), dealt with experiments on the brain of the chimpanzee. The brain of the chimpanzee is, after that of the gorilla, the brain which approaches most nearly to that of man himself. The experiments undertaken had been the ablation of certain portions of the cortex with the view to study the after effects upon the behaviour and movements of the animals observed. The cerebral cortical centre for the right hand had first been carefully exposed and delimited by excitation with faradic currents. All that region of the cortex which had under excitation provoked movement commencing in the right hand had then been destroyed. The immediate effect of the injury had been paralysis of the hand, with a less degree of paralysis of the wrist and shoulder. In the course of five weeks, however, recovery had been so marked as to restore to the hand its uses almost completely, as far as mere inspection could decide. The animal often used the hand and sometimes fed itself on fruit, &c., from it alone, without use at all of the left hand. The right arm had in the course of even a fortnight recovered its use for climbing, &c. Examination of the spinal cord for the degeneration of tracts following this lesion led to the discovery of an anthropoid feature in the cord not previously found in any spinal cord except the human, namely, a fully-developed "direct pyramidal" tract. In another individual a limited destruction of the cerebral cortex in the leg-region of the "motor" area produced at once severe but short-lasting paralysis of the leg, with immediate increase of the knee jerk. The paralysis seemed in the course of four weeks to have passed away, although there still remained marked exaggeration of the knee jerk. The spinal degeneration when examined revealed no direct pyramidal tract in this case: either, therefore, the existence of that tract is subject to great individual variation or the tract is not connected with the more mesial portion of the motor area. Ablation of the posterior part of the left inferior frontal convolution did not produce any obvious alteration either of the character or of the amount of the vocal sounds uttered by the animal. The animal "talked" as much and apparently as variedly after as before the cortical lesion. Regarding descending tracts which degenerated in the spinal cord after lesions of the cortex it was noteworthy that the lesions which produced spinal degeneration were in every case situate in front of the fissure of Rolando. A further point of interest was that the degeneration descending from lesion of the hand area extended down along the spinal cord as far as the top of the lumbar region. Microscopic specimens were demonstrated in illustration of these points.

Dr. Edridge-Green followed with a paper on colour-vision. He developed his well-known views on the classification of the various types of colour blindness. He urged the unsatisfactory character of the test followed in using Hohngren's coloured wools, and the advantage of replacing that test officially by a lantern-test. Dr. J. Wanklyn read a paper on arsenical pigmentation of the skin, and Dr. W. A. Osborn recounted observations on the physical properties of caseinogen salts in solution.

On Friday, September 13, the proceedings opened by a most lucid and interesting paper by Prof. McKendrick on the registration of sounds. His description was richly illustrated both pictorially and by experiment. It proceeded to deal with the subject in its historical development. The methods adopted for the registration of speech sounds from 1875 onwards were shown. The gradual evolution of the phonograph was traced, and of the methods employed for the analysis of the marks made upon the wax cylinder of that instrument. There were special characteristics about vocal sounds which distinguished them from all the sounds of musical instruments. Language would come to be recorded, not by such symbols as are used at present for words and syllables, but by less arbitrary and more reasoned systems. It had been suggested that the signs should indicate what had to be done by the vocal and articulating organs for the production of any given sound. Prof. McKendrick then examined the various theories put forward regarding the formation of vowel sounds. He spoke especially of the recent researches of Dr. Marès, of the Physiological Institute of the Sorbonne, Paris. Marès had approached the problem from a very original point of view, regarding the grouping of the vibrations, in the internal sequence rather than the external sequence, as of main influence. Using a syren with plates per-

forated according to the sequences observed in the flame pictures, &c., of vowel sounds and adding to the syren certain resonators which were faithfully moulded on the shapes taken by the mouth in utterance of vowels, Marès had succeeded in reproducing the vowel sounds with a degree of fidelity surpassing those of all previous efforts. Prof. McKendrick urged the phonographic registration of dialects. Such a collection of phonographic records would be of help to the science of language. How little could we tell to-day of the spoken sounds of ancient Sanskrit, of how Demosthenes spoke in Greek or Cicero in Latin; how little also of the exact accent of Shakspeare's English. Finally, a demonstration was given of the practical efficiency of the intensification of the sounds of a phonograph by causing their waves to fall upon a microphone and that instrument in turn to affect a loud-speaking telephone.

Dr. R. Kennedy (Glasgow) read a paper on return of voluntary movements after alteration of the nerve-supply by nerve-crossing or anastomosis. His experiments on animals had shown that when the nerve supplying the flexor muscles of a limb were divided and cross-united to the nerves supplying the extensor muscles, the animal in time regained the functional use of the limb, although the innervation of the muscle groups was reversed. The nerve-centres for the flexor and extensor muscles interchanged their positions and could be thrown into appropriate activity for the crossed relations of the muscles. This principle of nerve-crossing found a practical application in many cases of paralysis of a muscle or group of muscles supplied by a particular nerve. A portion of the nerve below the lesion could be grafted on to a neighbouring normal nerve with probability of restoration of the function of the paralysed muscles. Photographs were shown of a case of facial spasm which he had relieved by dividing the facial nerve and grafting its distal end on to the spinal accessory. The result had been return of normal voluntary movement in the face and absence of spasm. But movements of the face tended to occur as an accompaniment of certain movements of the arm.

Prof. Waymouth Reid, F.R.S. (Dundee), discussed the question "Can solutions of Native Proteids exert Osmotic Pressure?" Of the two methods of testing this question, namely, cryoscopy and direct measurement against a membrane impermeable to proteid, the latter alone is likely to lead to a satisfactory answer. Against the cryoscopic method would be the high molecular weight and errors due to traces of salts not fully eliminable by observation on solution of the ash. The method of direct measurement is liable to error in the possibility of presence of a contamination (not salts) which, like proteid, cannot pass the membrane, and so if in solution exerting osmotic pressure. A true finding on the point is only likely to be reached by working with "solutions" of pure proteid. The experiments of Starling with blood serum led to variable results, the osmotic pressure for the 1 per cent. concentration of the proteids in their native fluid being given as from 2·97 to 5·29 mm. Hg. at room temperatures. These experiments prove that substances exist in solution in serum to which a gelatine membrane is impermeable, but they do not prove that the osmotic pressure observed is due to the proteid constituent either in part or *in toto*. The proteid might be inactive *quâ* production of osmotic pressure, and some other constituent of serum in solution might be responsible. A well-dialysed solution of once crystallised horse serum-albumin gave osmotic pressure on a formalised gelatine membrane against distilled water in a rocking osmometer, a pressure which after fourteen days had settled to 15·5 mm. Hg. for the 1 per cent. concentration of proteid.

The pressure remained constant at this level for another six days (*i.e.* until the twenty-first day of experiment), after which the observation was stopped. Had the experiment been stopped six days after the start the estimate of osmotic pressure would have been 28 mm. of mercury for the 1 per cent. concentration of proteid, a level at which it stood constant till the ninth day.

The membrane was proved impermeable to proteid by the ordinary tests, but the preparation of serum-albumin was also proved impure, for it held more than 17 per cent. of nitrogen.

Ovalbumin is so readily crystallised and recrystallised by Hopkins' modification of the Hofmeister method that we can probably assure ourselves of the purity of this proteid better than of that of any other from an animal source.

With "solutions" of recrystallised and well-washed ovalbumin (15·41 per cent. of nitrogen) no pressure can be got on a natural or formalised gelatine membrane, proved (at the end of the experiment) impermeable to the proteid.

Dilute "white of egg" in contrast gives a lasting pressure against its filtrate through a gelatine filter, at similar concentration in proteid. The addition of sodic hydrate to the "solution" of ovalbumin, within the limits of appearance of alkalinity to litmus or phenolphthalein, does not affect the negative result.

Finally, a "solution" of crystallised hemp-seed globulin in sodic chloride solution put against the original salt solution gave no pressure on a gelatine membrane proved impermeable to the globulin at the end of the experiment.

If these experimental results are borne out by those still in progress, the conclusion of many will be strengthened, viz. that such so-called solutions are only suspensions, since the power to exert osmotic pressure on a suitable membrane is our most convincing test of solution in the case of a non-electrolyte.

Prof. Waymouth Reid also read a contribution to the study of ionic effects as exemplified in the small intestine. The action of salts in solution upon various vital phenomena has long been studied, but the subject is prominent just now as a result of the brilliant experiments of Prof. Loeb and his pupils.

From a general point of view his more important conclusions are:—

(1) Several different metallic ions are necessary for the exhibition of vital phenomena, and the nature of these and their optimum relative proportions vary in different tissues and classes of vital phenomena, even in one and the same animal.

(2) One can impart to a living tissue new properties by changing the quality and the relative proportions of the ions in it.

The sodium ion is the most active in starting rhythmical construction of skeletal muscle, but other ions must be present in addition, otherwise by mere excess the sodium becomes a poison.

Again, we cannot reason from the action of a given ion upon one tissue to its action on another, even if the second tissue performs functions which are superficially analogous.

Thus Lillie observed that in the larva of *Arenicola cristata* ciliary motion continued in solutions of calcium, magnesium and potassium salts which stopped the activity of the muscles of the body, while contraction of the body-muscles continued in solutions of sodium salt which stopped the motion of the cilia.

Potassium ions, so poisonous to cardiac muscle, may be beneficial to the action of other protoplasms. Loeb found that the early development of *Fundulus* embryos was favoured by potassium ions up till the formation of the heart.

In the eggs of the marine annelid *Chaetopterus*, which when unfertilised do not develop in sea-water, an artificial parthenogenesis can be started by potassium ions, and the action is ionic and not osmotic as in some parthenogeneses. Here the potassium ion acts as a specific stimulant. One would expect that if the cells of the mammalian intestine take an active part in the process of absorption a variation of the preponderating ion in the solution of the substance the absorption of which is being studied might affect the absorption of the substance by the gut wall.

In the experiments glucose was selected for study since it is normal to the intestine and capable of fairly accurate estimation, and the absorption of isotonic solutions of glucose in sodium and potassium chloride solutions were compared.

The results so far have indicated that a preponderance of the potassium ion over the sodium ion favours the uptake of glucose, about half as much again of the glucose being absorbed from solutions holding potassium chloride as from solutions of equal molecular concentration holding sodium chloride.

Unfortunately, the ionic effect can only be studied, in this case, from the cavity side of the membrane, on account of the highly poisonous action of potassium upon the heart muscle when exhibited in the circulating blood. Experiments with other ions were in progress.

Dr. Albert A. Gray (Glasgow) read a paper on some methods of preparation of the inner ear, with remarks on its function. He showed a new method of preparing the membranous ear by first supporting the structure and then destroying the surrounding bone. From these preparations he drew inferences regarding the phenomena of giddiness and of the theories of hearing. A preparation was shown of the entire internal ear. After first embedding preparations in a firm substance the surrounding bone was decalcified by nitric acid, and the whole was rendered transparent by oil of thyme. The demonstration of the upward increase in width of the ligamentum spirale of the cochlea was a matter on which Dr. Gray especially laid stress.

Dr. Noel Paton (Edinburgh) gave on behalf of himself and Drs. Gulland and Fowler some account of experiments in examination of the asserted hæmatopoietic functions of the spleen. His previous work had shown that the spleen exerted no

detected influence upon the course of chemical digestive changes in mammals. The question remained, "Is the spleen connected with production of blood corpuscles?" The methods he and his colleagues had employed were (1) comparison of corpuscles in blood entering and leaving the spleen; (2) effect of removal of spleen on number of blood corpuscles; (3) the rate of recovery of the number of corpuscles in animals with and in animals without spleen after hæmorrhages and after hæmolytics.

The results obtained by these methods were:—(1) No difference observed in blood of splenic vein and splenic artery. Rollett's well-known statement in Stricker's "Handbuch" of the great relative increase of leucocytes in the blood of the splenic vein was therefore not confirmed. (2) Removal of the spleen (dog, rabbit, cat) produced no perceptible change in the number of corpuscles in the blood. (3) Recovery of number of corpuscles after hæmorrhage and hæmolytics proceeded as fast in the animals without spleen as in those with spleen.

Dr. W. Brodie Brodie (Glasgow) made a communication on the action of oxalates on the calcium of muscle. From a series of observations made it was argued (1) that the action of oxalates in destroying muscular irritability was only manifest when the muscle was thrown into repeated contractions; (2) that the irritability of resting muscles was not injured by oxalates; (3) that it was probable that calcium was liberated from a complex compound when the muscle entered into contraction.

Dr. W. H. R. Rivers (Cambridge) communicated the results of testing the vision of natives of Murray Island and that of a number of English people with the visual illusion known as the Müller-Lyer. This well-known illusion is one in which additional straight lines lengthen or shorten in appearance an original straight line according to the inclination of the direction toward it. By means of a slide the line could be made of the same length as a standard line. Observations were carried out on forty-two English people and thirty-eight natives of Murray Island, between New Guinea and Australia. Each person made ten trials. The standard line measured 75 millimetres; to the average English person the line compared with it appeared equal to it when of 53 millimetres length. The average Murray Islander made the line 60 millimetres, so that the illusion was less pronounced with him than with the average English observer. There was marked agreement among the Murray Island men, who were as uncultured and unskilled in the European sense as any population could be. The Murray Islanders, though they could be regarded as savages, were yet able to make these observations very well. When Dr. Rivers went out on his expedition he anticipated great difficulty in getting people of that degree of civilisation to enter into the making of such observations. He had, however, in fact found that they made them with even more attentiveness than the average Englishman could be induced to give to the test. The English individuals tested could be divided into two classes, those acquainted with the illusion, such as students of psychophysiology, and those who were roughly acquainted with it through the advertisements of soap manufacturers, &c. It was interesting that the results obtained from both these classes were practically the same. The English individual when told to make the two lines equal as he saw them no doubt sometimes involuntarily corrected to some extent the tendency developed in the illusion. The Murray Islanders gave more consistent results than the Europeans. This greater consistence may have been due to the total ignorance by the Islanders and their thus remaining uninfluenced by speculation founded on knowledge of the illusion. Prof. McKendrick, in thanking Dr. Rivers for his valuable communication, urged the great interest, both practical and theoretical, of the labour of psycho-physiologists. At present the labour was chiefly the accumulation of facts many of which as yet were difficult to coordinate into general laws. It was exceedingly important that the subject should be seriously taken up in this country. In the American schools a great deal of useful progress was being made.

On Tuesday, September 17, Dr. C. S. Myers (Cambridge) communicated the results of a series of observations made with Galton's whistle upon the hearing of the Murray Islanders and some inhabitants of Buchan, Aberdeenshire. The result showed that the Murray Islanders could not at any age hear such high-pitched notes as the people of Buchan. The latter had from childhood upward a finer perception for high-pitched notes than the former.

Prof. Marcus Hartog demonstrated a model showing the mechanism of the frog's tongue.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 230th meeting of the Junior Scientific Club was held on November 29. Dr. Gustav Mann (New College) read a paper on the theory of dyeing and staining, and Mr. D. A. Gilchrist one on agricultural experiments at Reading and in Canada.

Mr. A. J. Jenkinson, of Hertford College, has been elected to the John Locke scholarship in mental philosophy.

Mr. G. W. S. Farmer, of Balliol College, has been appointed Litchfield lecturer in clinical surgery for two years.

CAMBRIDGE.—The Allen scholarship for research in medicine, mathematics, physics and chemistry, biology and geology, or moral science, will be awarded in the ensuing Lent Term. The emolument of the student is 250*l.* for one year. Any graduate of the University is eligible, provided he is not more than twenty-eight years of age on January 8, 1902. Candidates must send their names, with a definite statement of the course of research they propose to undertake, to the Vice-Chancellor by February 1, 1902.

THE annual prize distribution and members' and students' conversazione of the Northampton Institute, Clerkenwell, will be held to-morrow, December 6. The Marquis of Northampton will distribute the prizes.

MR. HERBERT J. FLEURE, a student of Prof. Ainsworth Davis at University College, Aberystwyth, has been elected a Fellow of the University of Wales. The Fellowship is one of the highest distinctions of the University, and its conferment for the first time upon a student who has been engaged in zoological research is of noteworthy interest.

THE influence which the universities in Germany have had upon industrial progress was emphasised by Prof. Senier in an address entitled "Bonn on the Rhine: Pages from its History and Stray Thoughts on Education" (Dublin: Edward Ponsonby), recently delivered at Queen's College, Galway. It is sometimes thought that the advance of German industry has been due to technical schools, but Prof. Senier remarks: "Probably it would be more correct to say that the technical schools are due to the rise of industries. No doubt technical schools have had and will have some effect in assisting manufactures. But the main source of those industries depending upon science has always been and must always be science itself, the outcome of university work." In this opinion Prof. Senier follows what the readers of NATURE have been familiar with during the last twenty years.

A GIFT of 5000*l.* has been offered to the University of St. Andrews by Dr. T. Purdie, professor of chemistry in the University, for the purpose of building and equipping a small chemical research department. In his letter to Principal Donaldson intimating the gift, Prof. Purdie says that their universities are very poorly provided for research when compared with those of foreign countries, and that scientific industries suffer in consequence. At St. Andrews in particular, except in zoology, there is no special provision in any of the science departments for original investigation. He therefore trusts that the University Court will accept his gift for the purpose mentioned, and that means may soon be found to equip other science departments. The success of the scheme, however, presupposes that scholarships will be available to encourage students to undertake post-graduate work, and also that an annual grant of money will be provided for laboratory expenses. He makes it a condition of his gift that the Carnegie trustees shall regard the scheme with favour and signify their willingness to help in the direction indicated. The gift is made in memory of his late uncle, Mr. Thomas Purdie, of Castlecliffe.

So many subjects are dealt with in the latest report of the U.S. Commissioner of Education that it is impossible to do more than mention a few matters considered in this volume, the contents of which occupy as many as 1280 pages. An account is given of the origin, growth, influence and relation to the public of the great secondary schools of England. The change in the character of secondary instruction in some schools from the old exclusively classical system to one related to modern requirements is pointed out in connection with its cause—the demands of commerce and industry. The national conservatism appears in the slow rate of change and the spirit in which science is even now accepted in the secondary school

curriculum. A detailed table of the schools of Berlin is given in the report, and it shows a surprising variety of educational agencies in the German capital. The table reveals the fact that Berlin has 103 secondary schools and 306 elementary schools. It is evident from the table that the city is making great efforts to assist the industrial education of its youth. Another article in the report contains a statement of the number of students in higher institutions of learning in fifteen prominent countries. The tables show, first, that the Teutonic nations—Germany, Austria, Switzerland, Belgium and the Netherlands—are in the front rank, not only in the number of students in higher institutions, but also in the ratio of increase. Second, that the percentage of increase in students of technical institutions, such as polytechnic institutions, agricultural and mining schools, is everywhere larger during the year 1898-99 than in those of universities and colleges. We note, for instance, that the attendance in universities in Germany increased 6·5 per cent., but that of technical institutions increased 8·2 per cent. In Austria the increase in universities was 4 per cent. ; in technical institutions it was 7·8 per cent. In Russia the increase in universities was 1·2 per cent. ; in technical institutions it was 7·7 per cent. Such figures are significant, inasmuch as they indicate that the industries of Europe and America are claiming more thorough and more special preparation than formerly.

SCIENTIFIC SERIAL.

Transactions of the American Mathematical Society, vol. ii. No. 4, October.—Geometry of a simultaneous system of two linear homogeneous differential equations of the second order, by E. J. Wilczynski, is a continuation of a previous paper (in No. 1 of the present volume), entitled "Invariants of Systems of Linear Differential Equations." In this some new theorems are deduced, but it is mainly concerned with geometrical interpretations. The author confines himself to the special case of the equations

$$y'' + p_{11}y' + p_{12}z' + q_{11}y + q_{12}z = 0,$$
$$z'' + p_{21}y' + p_{22}z' + q_{21}y + q_{22}z = 0,$$

the independent variable being x. The consideration of configurations in hyperspace is avoided. The treatment is connected with the work of Halphen and Fano upon the single linear differential equation (*cf. Math. Annal.* vol. liii.).—The chief result of Dr. L. E. Dickson's theory of linear groups in an arbitrary field is the exhibition of four infinite systems of groups of transformations which are simple groups in every domain of rationality. For the case of the field of all complex numbers these groups are the simple continuous groups of Lie. The chief results in a finite field are given in the author's "Linear Groups" (Teubner, Leipzig, 1901). Corresponding to the isolated group of 14 parameters, there exists in the Galois field of order p^n a new system of simple groups of order $p^{6n}(p^{6n}-1)(p^{2n}-1)$.—On certain aggregates of determinant minors, by W. H. Metzler. In 1888 Dr. T. Muir showed (*Proc.* Roy. Soc. Edin., pp. 99-105) that a linear rotation exists between certain minors of a centro-symmetric determinant similar to Kronecker's relation between the minors of an axi-symmetric determinant ; and in 1900 he gave two theorems connecting the minors of any determinant, the first of which reduces to Kronecker's relation and the second of which reduces to his 1888 relation.—Prof. Metzler extends these relations and gives a series of types of linear relations between the minors of a centro-symmetric determinant. The present memoir gives the number of relations of each type.—Two papers by A. Pringsheim are (1) ueber die anwendung der Cauchy'schen multiplications regel auf bedingt convergente oder divergente reihen, and (2) ueber den Goursat'schen beweis des Cauchy'schen integralsatzes. These, as well as several of the other papers in the number before us, were communicated to the Ithaca meeting of the Society (August 19).—New proof of a theorem of Osgood's in the calculus of variations, by Oskar Bolza, is a simple one of the important characteristic property of a strong minimum in the calculus.—On certain pairs of transcendental functions whose roots separate each other, by the same author, proves the theorem, if, in a certain interval, p, q, ϕ_2, ϕ_1, ψ_2, ψ, are continuous real functions of the real variable x, and if the last four of these functions have continuous derivatives, then, y being a solution not identically zero of the differential equation $y'' + py' + qy = 0$, the roots of the functions $\phi_2 y' - \phi_1 y$, $\psi_2 y' - \psi_1 y$ will separate each other if no one of the three functions $\phi_1\psi_2 - \phi_2\psi_1$, $\phi_1'\phi_2 - \phi_1\phi_2' + \phi_1^2 + p\phi_2\phi_1 + q\phi_2^2$, $\psi_1'\psi_2 - \psi_1\psi_2' + \psi_1^2 + p\psi_2\psi_1 + q\psi_2^2$ vanishes at any point of the interval in question. Certain extensions of the above theorem are also established.—On the system of a binary cubic and quadratic and the reduction of hyperelliptic integrals of genus two to elliptic integrals by a transformation of the fourth order, by J. H. Macdonald, effects the reduction by a special involution of order four containing a form which is the square of a quadratic. Reference is made to Prof. Bolza's inaugural dissertation (Göttingen, 1886). The sections discuss theorems on the biquadratic involution having a complete square, the system of a cubic and two linear forms and their conjugate system, the system of a cubic and quadratic and their conjugate system, certain involutions, and miscellaneous results on biquadratic involutions containing a complete square.—On the theory of improper definite integrals, by E. H. Moore. In the paper the author discusses the types connected with the names of Cauchy, Riemann, du Bois-Reymond, Dini, Schoenflies, Harnack and Jordan, Hölder, and de la Vallée-Poussin. Prof. Moore himself defines a system of types, which differ according to the way in which the integral depends (by definition) upon the sets of points of singularity of the integrand function with respect to definite integration.—On the convergence and character of the continued fraction $\frac{a_1 z}{1} + \frac{a_2 z}{1} + \frac{a_3 z}{1} + \dots$, by E. B. Van Vleck, is a portion of the paper, contributed by the author to the August meeting of the Society, on the convergence of the continued fraction of Gauss. In this portion the theorem established is—if, in such a fraction, the greatest modulus of any point of condensation of the sequence $a_1, a_2, a_3, \dots$ is k, then within a circle of radius $1/4k$, described about the origin as centre, the continued fraction will represent an analytic function, and the only singularities of the function contained within the circle will be poles. In any region excluding these poles and lying in the interior of the circle the convergence will be uniform.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"The Pear-shaped Figure of Equilibrium of a Rotating Mass of Liquid." By Prof. G. H. Darwin, F.R.S.

"Sur la Stabilité de l'Équilibre des Figures Pyriformes affectées par une Masse Fluide en Rotation." By H. Poincaré, For. Mem. R.S.

"On the Process of Hair Turning White." By E. Metchnikoff, For. Mem. R.S.

Although the fact of hair turning white is a most familiar one, its mechanism has not as yet been unveiled. The authors of works on hair and dermatology acknowledge their ignorance concerning this subject.

Having undertaken a study on atrophic processes, and especially on senile atrophy, my attention has been called to the atrophy of hair pigment so frequent in old people.

Observations on grey hair, or on hair beginning to turn grey, showed me that the atrophy of its pigment is due to the intervention of phagocytes of the hair.

These cells have a single nucleus and their very different aspect one from another is due to numerous amœboid prolongations of their protoplasm. They are derived from the medullary part of the hair and make their way out into its cortical layer, where they absorb the pigment granules, which they then remove from the hair.

If we consider hair, one part of which is already white and the other still pigmented, we find a great many of these phagocytes. They are supplied with greatly developed prolongations and become insinuated between the keratic cells of the peripheral layer.

In absolutely white hair the phagocytes filled with pigment become more and more scarce, and most frequently completely disappear.

It is thus indubitable that the phagocytes of the hairs swallow up the granular pigment of the cortical layer and transfer it elsewhere, the result being the complete whitening of such hair. On observing the root of hair beginning to whiten, we often find a great many phagocytes filled with pigment.

The whitening of the hair of old dogs proceeds by the same mechanism. We equally find here a great number of phagocytes

supplied with numerous prolongations and stuffed with pigment granules.

The part played by phagocytes in the whitening of hair explains many phenomena observed long ago, but not as yet sufficiently understood. Thus, hair turning white in a single night, or in a few days, may be explained by the increased activity of hair phagocytes thus enabled to transfer the pigment in so short a time.

The mechanism of the whitening of hair through the agency of phagocytes allows this case of atrophy to be classed under the general laws of atrophy of solid parts of the organism.

"On the Inheritance of the Mental Characters in Man." By Karl Pearson, F.R.S.

(1) Mr. Francis Galton, in his "Natural Inheritance," first, I believe, endeavoured to give a *quantitative* appreciation of the inheritance of the mental characters in man. Mr. Galton's data were not very copious, and in default of a method of dealing quantitatively with characters not capable of exact scaling, it was not possible to deduce absolutely conclusive results. On November 19, 1899, a paper was read to the Royal Society showing how the inheritance of characters not capable of exact quantitative measurement might be deduced. I purpose in this notice to give only a few results from some very elaborate observations which have been made in the course of the last few years and reduced by the processes of that paper.

(2) The material was collected in two separate ways. In the first series—the Family Measurement Series—only physical characters were observed. This series was started six years ago, and upwards of 1100 families, father, mother, and not more than two sons and two daughters, were measured. The series was closed two years ago, and last year Dr. Alice Lee completed the reduction of this very large mass of material.

My second series is still more extensive; but it relates only to collateral—fraternal—heredity. It aims at observing a wide range of both physical and mental characters in pairs of school children. I have received most kindly aid from a great number of masters and mistresses in public schools, high schools, secondary and primary schools of all classes. This will be very fully acknowledged in the final publication of the results. But although the work has been in progress for three years, we have still only material enough to draw conclusions in the case of pairs of brothers, of whom more than 1000 cases have been observed.

(3) Only three of the physical measurements of this extensive series have yet been reduced, and the sister-sister and sister-brother observations will have to be carried on for another year or two before they are sufficiently numerous to be dealt with. The whole material will then require two or three years for tabulation and calculation. But as the problem of the inheritance of the mental characters and their correlation with the physical was occupying our attention in another field, the indefatigable Dr. Lee undertook the tabulation and calculation of the coefficients of heredity in the case of seven mental and three physical characters for pairs of brothers. The number of pairs dealt with in each case was 800 to 1000. The method adopted was that of the memoir on "The Inheritance of Characters not capable of Exact Quantitative Measurement."[1] Thus, under the heading *Conscientiousness* were two divisions, Keen and Dull, and the teacher might place a cross on either of these or on the dividing line. Similar divisions occurred in the other categories, except that *Intelligence* was given six and *Temper* three subdivisions, &c. The sole object in the present preliminary notice is to draw attention to the following results:—

Coefficients of Collateral Heredity.

Correlation of Pairs of Brothers.

Physical Characters. (Family Measurements.)		*Mental Characters.* (School Observations.)	
Stature	0·5107	Intelligence	0·4559
Forearm	0·4912	Vivacity	0·4702
Span	0·5494	Conscientiousness	0·5929
Eye-colour (School Observations.)	0·5169	Popularity	0·5044
		Temper	0·5068
Cephalic index	0·4861	Self-consciousness	0·5915
Hair-colour	0·5452	Shyness	0·5281
Health	0·5203		
Mean	0·5171	Mean	0·5214

The physical characters were measured or observed on two entirely different groups of individuals—in the one case adults, in the other children were examined. The means for both series are almost identical (·5170 and ·5172). Dealing with the means for physical and mental characters their likeness forces us to the perfectly definite conclusion: *That the mental characters in man are inherited in precisely the same manner as the physical.* Our mental and moral nature is, quite as much as our physical nature, the outcome of hereditary factors.

[1] *Phil. Trans.* A vol. cxcv. pp. 79-150.

Entomological Society, November 6.—The Rev. Canon Fowler, president, in the chair.—The Rev. F. D. Morice exhibited two imperfectly developed females of *Osmia leucomelana* found dead in a *rubus* stem at Woking with their cases.—Mr. C. P. Pickett exhibited a series of aberrations of *Colias hyale* taken at Folkestone during August 1900-1.—Mr. F. B. Jennings exhibited a specimen of *Trachyphloeus myrmecophilus*, Seidl., taken at Hastings in September last, retaining intact the deciduous "false mandibles," with the aid of which the imago of the species of this and certain other genera of weevils is said to work its way to the surface after emerging from the pupa underground. These mandibles are usually shed as soon as the imago begins its life above ground, as there is no further use for them.—Mr. W. J. Kaye exhibited a collection of butterflies made by him in Trinidad, with several hitherto undescribed species. He said that the probable total rhopalocerous fauna was about 250 species, the island—about the size of Somersetshire—being thus remarkably rich in butterflies. The number of the species in the families exhibited were Nymphalidæ 34, Satyridæ 13, Papilionidæ 6, Pieridæ 31, Erycinidæ 29, Lycænidæ 27, Hesperiidæ 62—nearly all taken within three or four miles of Port of Spain. The series of *Heliconius telchinia* and *Tithorea megara*, var. *flavescens*, were particularly fine, showing the yellow coloration only found in Trinidad and the coast of Venezuela immediately opposite. A long series of *Papilio xeuxis*, and *Papilio alyattus*, many of them bred from the same parent ♀, show that these two are in reality identical species. The number of Erycinidæ in Trinidad compared with the poverty of the same species in other West Indian islands indicates the different origin of its fauna, and suggests affinity with the mainland of Venezuela, which at the nearest point is but seven miles distant.—Dr. Chapman exhibited specimens of *Parnassius apollo* taken last July in Castile and Aragon (Spain), as well as a number of specimens of both *P. apollo* and *P. delius*, chiefly Swiss and French, taken by himself, Mr. Tutt, Mr. A. H. Jones (at Digne), and Mr. Rowland-Brown (at Susa, N. Italy), for comparison with the Spanish specimens and to illustrate the extent to which the races of these species approach each other in western Europe.—Mr. G. C. Bignell sent for discussion a specimen of *Sphecophaga vesparum*, Curt., and the cocoon from which it had been bred.—Mr. Gilbert J. Arrow communicated a paper upon the genus Hyliota, with descriptions of new forms and a list of described species, and Mr. W. L. Distant, contributions to a knowledge of the Rhynchota.

Royal Meteorological Society, November 20.—Mr. W. H. Dines, president, in the chair.—A paper by Mr. A. Lawrence Rotch on the exploration of the atmosphere at sea by means of kites was read by the secretary. The author has for some years past devoted his attention to the use of kites to obtain meteorological observations at the Blue Hill Observatory, Mass., U.S.A., and he has successfully carried on the work of exploring the air there to a height of three miles by several hundred kite flights executed in varied weather conditions whenever the velocity of the wind exceeded twelve miles an hour. Certain types of weather, however, such as anti-cyclones, accompanied by light winds, can rarely be studied. Mr. Rotch now proposes the employment of kites carrying meteorographs on steamships, especially on vessels cruising in tropical oceans. He has himself demonstrated the practicability of this scheme, as on August 22 last he raised a kite to an elevation of half a mile from a tow-boat in Massachusetts Bay, when the velocity of the wind at sea-level varied between six and ten miles an hour. At the end of the same month, when crossing the North Atlantic from Boston to Liverpool on the steamship *Commonwealth*, he was able to raise kites carrying a meteorograph to an altitude of 1600 feet on five days out of the eight. The chief feature of these records was the rapid change of temperature with height.—A paper by Prof. J. Milne, F.R.S., on meteorological phenomena in relation to changes in the vertical, was also read by the secretary. When resident in Japan some years ago the author carried on numerous observations by seismographs for ascertaining changes in the vertical, and found that

the more important displacements of the horizontal pendulums are of three types, viz. intermediate, long and short period wanderings. During the last five years Prof. Milne has had continuous photographic records of a horizontal pendulum at his residence at Shide, Isle of Wight, and he now makes a comparison of these records with the weather conditions prevailing during the first six months of 1901. He says that assuming that a locality can be chosen where the diurnal wave and effects due to rain and desiccation are small, which his observations indicate as possible, records of what appear to be the effects due to barometrical gradients may be obtained. When these are large and appear suddenly, the movements of the pendulum may be marked. At Shide the westerly displacement of a pendulum has, for several years past, been regarded as indicating the approach of bad weather.

Anthropological Institute, November 12.—Mr. W. Gowland, vice-president, in the chair.—Mr. R. Shelford exhibited (1) a series of slides of natives of Sarawak, and (2) a collection of gold jewellery found in Borneo, lent by H.H. the Rajah of Sarawak.—Mr. Shelford read a paper entitled "A Provisional Classification of the Swords of the Natives of Sarawak."—Mr. J. Gray exhibited a craniometer for measuring the height of the head.

November 26.—Mr. C. H. Read, ex-president, in the chair.—Mr. E. Willet exhibited a number of Palæolithic implements from Savernake.—Mr. N. W. Thomas exhibited a collection of "totem-stones" collected by the Hon. Auberon Herbert. The exhibit was discussed by Mr. Balfour and Mr. Read.—Mr. R. J. Gatty read a paper on dwarf flints from the sand mounds of Sennthorpe, illustrated by a number of specimens.

MANCHESTER.

Literary and Philosophical Society, November 26.—Mr. Charles Bailey, president, in the chair.—Prof. H. B. Dixon mentioned that Mr. H. Brereton Baker had succeeded in making a mixture of hydrogen and oxygen so pure that it would not explode when the vessel containing it was raised to a red heat or when a silver wire was melted in it. In one case some water was gradually formed, so that the explosion of the gases would seem to depend on the presence of some impurity other than steam itself.—Prof. F. E. Weiss exhibited two dwarf Japanese trees which have been purchased for the Manchester Museum. They were *Pinus parvifolia* and *Thuja obtusa* (the Japanese cypress), both natives of Northern Japan, where they grow at very great altitudes and are naturally of small growth. The trees exhibited, which were thirty and forty years old respectively, were only six to nine inches in height, these dwarf forms being obtained by a system of starving and pruning back the plants and by contortions of the stem and branches which retard the nutritive processes.—Mr. J. E. Petavel read a paper entitled "On the Measurement of High Explosive Pressures." After a short review of the various methods and instruments used by Rumford, Bunsen and Rodman in the first half of the nineteenth century, and by Noble, Berthelot, Vieille, Le Chatelier and Mallard in recent years, the author went on to describe a new form of recording gauge, which is, in principle, not far removed from the ordinary crusher gauge. The short copper cylinder is replaced by a hollow steel cylinder one inch in diameter and five inches long, the relative cross-sectional areas of the piston and cylinder being calculated so that the strains are well below the elastic limit of the material. The actual motion of the piston is thus limited to one or two thousandths of an inch, and a very high time period is obtained. The motion of the piston is transmitted to a mirror, the movement of which is photographically recorded on a revolving drum. The amplitude of the records thus obtained is about 1″; they can be measured to an accuracy of about one-thousandth of an inch. A number of records referring to mixtures of coal gas and air or oxygen and hydrogen were shown, the pressures ranging up to twelve thousand pounds per square inch.

PARIS.

Academy of Sciences, November 25.—M. Fouqué in the chair.—On the absence of action of a magnetic field upon a mass of air which is the seat of a current of displacement, by M. R. Blondlot. It has been shown in a previous paper that if a mass of air is moved in a magnetic field normally to the lines of force no electric displacement results in this mass of air. From this it follows that a mass of air which is the seat of an electric displacement should undergo no action in a magnetic field. If the principle of action and reaction is applied to this proposition it leads to the conclusion that a current of displacement in the air exerts no magnetic action, and consequently that the charging current of a condenser is an open current from the magnetic point of view. This is in direct opposition to one of the fundamental principles of Maxwell's theory, and choice has to be made between renouncing this theory or the principle of action and reaction.—On ibogine, the active principle of a plant of the genus Tabernæmontana, coming from the Congo, by MM. A. Haller and Ed. Heckel. In the Congo and neighbouring countries several species of plants possessing analeptic and stimulating properties are used by the natives under the name of Iboga. These peculiar properties have been assigned by MM. Dybowski and Landrin to a special glucoside, by M. Schlagdenhaufen to a new alkaloid. The specimens of this plant shown in the Colonial Exhibition of 1900 have been utilised for the extraction of this substance. The amount of material was small, but it is clear that the substance is a true alkaloid and not a glucoside, and the formula $C_{26}H_{32}N_2O_2$ is provisionally assigned to it. The alkaloid itself has been obtained in the form of white crystals, but all the salts obtained up to the present are amorphous.—The mummified birds of ancient Egypt, by MM. Lortet and Gaillard. The specimens examined differ greatly in their states of preservation, some being so perfectly preserved that a simple examination of the feathers was sufficient for the identification whilst in others the skeleton was the only possible guide. Some thirty-eight species were identified, the greater number of these not having been found before in the mummy state.—The *Okapia Johnstoni*, a new mammal allied to the giraffe discovered in Central Africa, by Prof. E. Ray Lankester. A drawing and description of a new mammal discovered by Sir H. Johnstone in the Semliki Forest on the borders of the Congo Free State and Uganda. The skin bears no resemblance to that of the giraffe, but its relationship to this animal is absolutely demonstrated by its skull. It may possibly be the living representative of the Miocene genus Helladotherium.—Remarks by M. Albert Gaudry on the preceding paper. M. Gaudry presented at the same time a restored head of Helladotherium.—M. Yves Delage was elected a member in the section of anatomy and zoology in the place of the late M. de Lacaze-Duthiers; M. Gouy, a member in the section of physics in the place of the late M. Raoult.—On the number of roots common to several equations, by M. A. Davidoglou.—The determination of some coefficients of self-induction, by Mr. G. A. Hemsalech. In a previous paper on the spectra of electric sparks the coefficients of self-induction were calculated from the dimensions of the coils. It has now been recognised that these were too great, and hence they have been redetermined experimentally. The most advantageous values for spark-spectrum observations are now given as ·00286 Henry for cobalt, zinc, magnesium and aluminium; ·00689 Henry for manganese aad silver; ·0254 Henry for antimony; and ·0419 Henry for iron, nickel, cadmium, tin, lead, bismuth and copper.—On the regular distribution of the magnetic inclination and declination in France up to January 1, 1896, by M. E. Mathias.—On the application of the clear chamber of Govi to the construction of a comparator for end standards, by M. A. Lafay. The arrangement described allows the difference in length between a standard and its copy to be expressed as the algebraic sum of the displacements of two plane mirrors mounted on micrometer screws. It has the advantage over the ordinary methods in avoiding all deformations due to the actual contacts of the ends of the standards with the holders used in the ordinary instruments.—On the combinations of aluminium chloride with the alkaline chlorides, by M. E. Baud. It is shown by thermochemical studies that the compounds $Al_2Cl_6.3NaCl$ and $Al_2Cl_6.3KCl$ exist, and very probably also $Al_2Cl_6.6NaCl$ and $Al_2Cl_6.6KCl$.—On the preparation of barium, by M. Guntz (see p. 112).—On a new volatile salt of beryllium, by MM. G. Urbain and H. Lacombe. A description of the preparation and properties of a basic acetate of beryllium. It boils under the ordinary pressure without any sign of decomposition at a temperature of 330–331° C., and its vapour density at the temperature of boiling mercury was found to be 13°·9, which is in accordance with the atomic weight Be = 9.—The action of fuming sulphuric acid upon acetaldehyde and propaldehyde and acetone, by M. Marcel Delépine.—On the electrolytic preparation of the halogen derivatives of acetone, by M. A. Richard. The electrolysis of mixtures of acetone with hydrochloric and hydrobromic acids gives monochloroacetone and monobromo-

acetone respectively. In the present paper the conditions necessary for a maximum yield of the halogen derivative are determined.—On the transformation by a new reaction of two xanthydrols into xanthenes, by M. R. Fosse.—The etherification of phosphorous acid by glycerol and glycol, by M. P. Carré.—On the reserve store of carbohydrates in the seed of *Aucuba japonica*, by M. G. Champenois. The seed of this plant contains a large quantity of cane-sugar accompanied by a glucoside. Besides the soluble compounds the seed contains as constituents of its hard albumen a galactane, a mannane and a pentane which give on hydrolysis galactose, mannose and a pentose which appears to be arabinose.—On an experiment of M. Berthelot relating to the transformation of glycerol into sugar by the testicular tissue, by M. Gabriel Bertrand. It is found that the action of the sorbose bacterium upon glycerol, which up to the present has been regarded as specific, is really an action common to different organisms.—Experiments on chlorophyll assimilation, by M. M. Harroy. The author has repeated the experiments of M. Friedel, but has not been able to confirm them, and he regards it as premature to state as a fact that the chlorophyllian synthesis may take place outside the vegetable organism and without the intervention of living matter.—Researches on the law of action of sucrase, by M. Victor Henri. The speed of inversion of saccharose by any acid is at any instant proportional to the quantity of saccharose present in the solution, from which is derived the well-known formula giving the relation between the time and the quantity present $k = 1/t \log a/a-x$. It is found that the inversion of sugar by sucrase takes place more rapidly than corresponds to this law, and a new formula is derived which expresses the experimental results better: $2k_1 = 1/t \log a+x/a-x$.—The cell of Sertoli and the formation of spermatozoids in the sparrow, by M. Gustave Loisel.—Some new geological observations in the Belledonne chain, by M. Pierre Termier.—A graphical method permitting the study of the circumstances of the course of a steerable aërostat, by the examination of the projection of its trajectory upon the earth, by M. J. Armengaud, jun.—The increase of the number of red corpuscles in the blood during a balloon ascent, by M. J. Gaule. It is shown that there is a true formation of red globules on arriving suddenly at a high altitude, the phenomena taking place with great rapidity.—The scientific treatment of deafness, by M. Marage.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.—On the Spontaneous Ionisation of Gases: C. T. R. Wilson, F.R.S.—In title only: Notes on Quantitative Spectra of Beryllium: Prof. W. N. Hartley, F.R.S.—Notes on the Development of *Paludina vivipara*, with Special Reference to the Urinogenital Organs and Theories of Gasteropod Torsion. (Preliminary Note): Miss I. M. Drummond.—In title only: Preliminary Account of the Prothallium of *Phylloglossum*: Prof. A. P. W. Thomas.

SOCIETY OF ARTS, at 4.30.—The New Trade Route to Persia by Nushk and Seistan: Edward Penton.

LINNEAN SOCIETY, at 8.—On the Foraminifera collected round the Funafuti Atoll from Shallow and Moderately Deep Water, with Notes on New Species from the Sands of the Reef Slope: F. Chapman.—Protoplasmic Connections in the Lichens: Dr. J. H. Salter.—Exhibition: Ten Abnormal Sacra of the Frog: Dr. A. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on the Formation of Diazoamines and Amino-azo-compounds: G. T. Morgan.—The Determination of Available Plant Food in Soils by the Use of Dilute Solvents: A. D. Hall and F. J. Plymen.—Some New Derivatives of Gallic Acid: F. B. Power and F. Shedden.

RÖNTGEN SOCIETY, at 8.30.—Bullets and their Billets: Experiences with X-Rays in South Africa: J. Hall Edwards.

FRIDAY, DECEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on a Recent Visit to Egypt: Dr. C. W. Andrews.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Gas-Engine Construction R. W. A. Brewer.

MONDAY, DECEMBER 9.

SOCIETY OF ARTS, at 8.—The Chemistry of Confectioners Materials and Processes: William Jago.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

IMPERIAL INSTITUTE, at 8.30.—The Maroons of Jamaica: H. T. Thomas.

VICTORIA INSTITUTE, at 4.30.—The Preparation of the Earth for Man's Abode: Prof. J. Logan Lobley.

TUESDAY, DECEMBER 10.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Train-Resistance: John A. F. Aspinall.—*Paper to be read*: Motive-Power from Blast-Furnace Gases: Bryan Donkin.

WEDNESDAY, DECEMBER 11.

SOCIETY OF ARTS, at 8.—Aluminium: Prof. Ernest Wilson.

THURSDAY, DECEMBER 12.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 5.30.—Flexure of a Circular Plate: J. H. Michell.—Non-uniform Convergence, and the Integration of Series: Dr. Hobson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Physical Properties of certain Aluminium Alloys and some Notes on Aluminium Conductors: Prof. E. Wilson (conclusion of discussion).—Some Principles underlying the Profitable Sale of Electricity: Arthur Wright.

CHEMICAL SOCIETY, at 8.—Extraordinary General Meeting.

FRIDAY DECEMBER 13.

PHYSICAL SOCIETY, at 5.—On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the Equivalent Radius of a Coil: Prof. Thomas R. Lyle.—Air Pressures used in playing Brass Instruments: Dr. Barton and S. C. Laws.—A New Hygrometric Method: E. B. H. Wade.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Dysentery in Asylums: Dr. Mott, F.R.S.

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