THURSDAY, AUGUST 10, 1899.

FLORAS FROM THE ROYAL GARDENS, KEW.

Flora Capensis: being a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal (and Neighbouring Territories), by various Botanists. Edited by W. T. Thiselton-Dyer, C.M.G., C.I.E., LL.D., F.R.S., &c., Director, Royal Gardens, Kew. Published under the authority of the Governments of the Cape of Good Hope and Natal. Vol. VI. Hæmodoraceæ to Liliaceæ. Vol. VII., Parts I. and II. Pontederiaceæ to Gramineæ. (London: Lovell Reeve and Co., 1896–97.)

Flora of Tropical Africa. Edited by W. T. Thiselton-Dyer, C.M.G., C.I.E., LL.D., F.R.S., &c., Director, Royal Gardens, Kew. Vol. VII. Hydrocharideæ to Liliaceæ. Published under the authority of the First Commissioner of Her Majesty's Works and Public Buildings. (London: Lovell Reeve and Co., Ltd., 1898.)

IT should not be necessary at this time of day to emphasise the fact of the imperial character of the Royal Gardens, Kew, still it would appear there are many inhabitants of Great Britain whose notion of the value of this establishment is limited by their desire for a local public park suited to the recreation of dwellers in and about London. Several incidents have of late shown this—witness the recent preposterous proposal brought forward in the House of Commons to throw the gardens open to cyclists! Suggestions of this kind are on the face of them, to those aware of the true character of the gardens, too absurd for discussion, yet there is an element of danger in this appeal to the selfish instincts of that large body of pleasure-seekers who are veritable Gallios in their contempt for science, especially when its just claims place an obstacle to the gratification of their pleasure whims. It is hardly conceivable that any First Commissioner of Works—and he is the Minister responsible for the gardens—would ever assent to such modification of the traditional character of the gardens as concession to the demand above referred to, which may be taken as symptomatic of a craze, would mean; yet in these days of political opportunism, and with a prospect of its even greater development, the preservation of the noble heritage the nation possesses in the Kew of the present becomes a question not altogether free from anxiety in the minds of those who know the services Kew renders and is capable of yet rendering to the Empire. Perhaps the surest way of avoiding disaster in the future is by making known far and wide what are its real functions and how they are discharged, for through the education of public opinion alone can an effective checkmate be given to any movement destined to sacrifice the scientific features of Kew at the altar of popular pleasure.

It is not the intention to discuss here the whole of the functions that belong to and are discharged by Kew—its value as an unrivalled microcosm of the vegetation of the world, its example as a school of horticultural practice, its position as a training ground for young gardeners, its use as an index of the products of the vegetable kingdom and as a nursery and centre of distribution of economic plants for the benefit of our Colonies—but to direct attention to the continued progress, indicated by the titles of the volumes cited above, of the large undertaking to which the energy and foresight of its first Director, Sir William Hooker, committed Kew—namely, the issue of a "Series of Floras" under the authority of the Home or Colonial Governments. Botanists are familiar with what has been already done by Kew towards the carrying out of this programme. The Australian Flora by Bentham and Von Mueller, that of Hong Kong by Bentham, of New Zealand by Dr. Hooker, of Mauritius and the Seychelles by Baker, of the West Indies by Griesbach, and the recently completed British Indian Flora by Sir Joseph Hooker are a tribute alike to the industry and talent of the botanists who have taken part in their production and to the importance of Kew in focussing botanical knowledge, as well as to the labours of our countrymen in the exploration of regions opened up to our occupation. The appearance of the volumes mentioned above has been particularly welcome, inasmuch as they denote a renewal of progress after a pause. The Flora Capensis was arrested after the publication of the third volume in 1865 by the death of Harvey, who, with Dr. Sonder, was its principal author; and of the Flora of Tropical Africa, the last of the three volumes brought out by Prof. Oliver appeared in 1877. The Director of Kew is to be congratulated upon having surmounted the hindrances which have contributed to the delay in continuing these Floras, and he will, it may be hoped, be encouraged to contend with and overcome all obstacles that may as it seems, threaten a steady advance to the conclusion of the works.

The volumes and parts before us are not in sequence with the volumes that have already appeared. As Sir William Thiselton-Dyer points out, once the plan of a work of the kind is settled it is immaterial what part first appears, and he has exercised a wise discretion in giving early attention to those groups of plants which are abundantly represented in our gardens, and which have consequently compelled special attention on the part of members of the Kew staff. The Monocotyledons have been therefore selected for first treatment in the resumed work upon the Floras, and we have the benefit of the ripe experience of Mr. Baker in the elucidation of the Liliaceæ, Irideæ, Amaryllideæ and allied orders, which are so popular in horticulture and form so large an element of the plant-life of South Africa, and to a less extent in the area embraced within the scope of the Tropical African Flora; Mr. Rolfe brings to the enumeration and description of the Tropical African Orchideæ a rare knowledge of the order; and Mr. N. E. Brown describes the Tropical African species of Disa as an expert. Tropical African Hydrocharideæ have fallen to the share of Mr. C. H. Wright, and the Cyperaceæ of South Africa find a sound critical exponent in Mr. C. B. Clarke; the account of the Gramineæ of the same area is in the able hands of Dr. Stapf, and should be completed in the next part of the Flora, for which we trust we shall not have long to wait.

In the continuations of these Floras we have the same standard of excellence to which preceding volumes have accustomed us, and which we therefore look for in publications coming from Kew. Their issue will be a boon not only to the professed botanical world, but also to all those who are interested in the many plants now known in, and still coming into cultivation from, Africa; and they should give a great stimulus to the further investigation of the vegetation of Africa and to the introduction of interesting and beautiful plants to the horticulture of the world.

No one looking at these volumes can fail to notice that their production at Kew, where a collection of living plants in a garden is associated with one of dried specimens in a herbarium, gives additional value to them. The necessity of the latter as a guide to the accurate determination of the nomenclature in a scientific garden is apparent; the service of the former as an adjunct to the herbarium by affording means for the study of the living plants in cases where the dried specimen can seldom be satisfactory is clearly brought out in the account of the groups of succulent monocotyledons treated of in these Floras. If all descriptive botanists were able, as is possible at Kew, to look at the dry bones of the plants with which they deal with some consideration of the form that clad them when alive, we should be spared much of that prolific synonymy which is the bane of the systematist. It is the possession of the finest collection of living plants along with a like one of dried specimens, through which it can contribute as in these Floras to the advance of our knowledge of the vegetation of the globe, that gives Kew an absolutely unique position as the leading botanical institution of the world, a position it has achieved in little over fifty years through the scientific ability and remarkable administrative capacity of its successive Directors, Sir William Hooker, Sir Joseph Hooker, and Sir William Thiselton-Dyer.

STATISTICAL METHODS APPLIED TO BIOLOGY.

Die Methode der Variationsstatistik. Von Georg Duncker. Pp. 75, with 8 figures in text. (Leipzig: Wilhelm Engelmann.)

THIS pamphlet, a reprint from the *Archiv für Entwickelungsmechanik*, is an attempt to render the formulæ and results of the statistical method somewhat more accessible to German biologists than they are, for example, in Prof. Karl Pearson's original papers. In the first part a complete outline is given of the fitting of frequency curves, normal or skew, to observed statistics, and in the second part a similar outline of the theory of correlation. The whole of this extensive ground is covered, however, in some sixty octavo pages, necessitating a degree of compression too great for satisfactory results. Proofs are necessarily almost wholly omitted, several difficulties likely to occur to beginners are slurred over, and there is more than one absolute blunder.

If $y = \phi(x)$ be any frequency curve, the frequency of deviations lying between $x - \frac{1}{2}c$ and $x + \frac{1}{2}c$ is given by the integral of the frequency-function $\phi(x)$ between those limits. If, and only if, c be very small, we may replace this integral by the product $y.c$ to a close degree of approximation. Hence, in any practical case of recording the distribution of frequency where we have to choose an arbitrary unit of grouping c, this should always be made as small as possible. If this be done, and if the number of observations be large, the observed frequency polygon closely approximates to a continuous curve, and the element of area round any ordinate differs very slightly from $y.c$. Moreover, the process of obtaining the moments of the observed frequency polygon by treating the observed frequencies as isolated loads, then differs very slightly in result from the process of continuous integration by which the moments of the theoretical curve were calculated. But if the element of grouping be not small, the element of area round y may differ very sensibly from $y.c$, and the process of calculating moments by treating group frequencies as isolated loads is not even a rough approximation to continuous integration. Hence Prof. Pearson's original preference of the moments of the trapezia system (*Phil. Trans.* A, 1895, "On Skew Variation," &c.), and Mr. W. F. Sheppard's papers on moment calculation (*Proc. Lond. Math. Soc.*, vol. 29, and *Journal Roy. Statistical Soc.*, vol. 60, 1897). This difficulty, due to the grouping, is entirely passed over by Herr Duncker. A series of observations giving only five base elements c is fitted without remark to a normal curve (Fig. 2). In every case the ordinates of the fitted curve are calculated only for the abscissæ of the observed ordinates, their tops are joined up, and the polygon so obtained called the "theoretical frequency polygon," as in Figs. 1, 2, 3—a procedure of somewhat dubious use in any case, and quite illegitimate where the elements are as large as in Fig. 2. If the author had not missed this fundamental point he would not, perhaps, have been so puzzled by Prof. Pearson's use of first one and then another method of calculating moments. It is a pity that all the arithmetical examples given of fitting frequency curves refer to cases of discontinuous variation, as these are naturally the material least suitable for representation by continuous curves.

There seems a corresponding lack of clearness in some fundamental points of the theory of correlation. The various formulæ for correlation coefficient, regressions, &c., are given, but the author nowhere clearly points out their meanings and limitations in cases of non-normal correlation. It is not noted that for complete independence the condition $r = o$ is, in general, necessary but *not sufficient*. The values of partial correlations are given, but it is not noted that only in normal correlation (so far as we know) is the partial correlation the same for every array. The correction given on p. 48 for reducing the product sum about an arbitrary pair of axes to the product sum about the mean is surely absolutely wrong; the different sums given are all of different dimensions. If S_0 be the value of the sum for axes through the mean, S_1 its value for the arbitrary axes

$$S_0 = S_1 - N.\,\bar{x}\,\bar{y},$$

where N is the number of observations and $\bar{x}\,\bar{y}$ are the coordinates of the mean with reference to the arbitrary axes. Of course this expression, and method of getting S_0, is quite well known, not novel as Herr Duncker seems to think.

Again, complete correlation does not subsist only when "every single deviation of the one characteristic corresponds to a precisely equal deviation of the other" (p. 43), but whenever the deviations are in any constant proportion. This definition, moreover, ought only to be held to apply to the case where the means of arrays lie on straight lines.

We do not like the definition of correlation as a "Beziehung . . . welche bewirkt. . . ." This is not a statistical definition, and confusion arises if the word be used carelessly, sometimes in one sense and sometimes in another. The definition of the correlation coefficient on p. 54 is much better; but why does the author call it a "morphological definition"? It is purely statistical.

The statement that it is mainly correlation which maintains the type ("die Korrelation ist es hauptsächlich, welche den Typus einer Formengemeinschaft aufrecht erhält") is a very pretty error; possibly due to the fact that biologists use correlation in a more "intensive" sense than statisticians do. Statistical correlation has absolutely nothing whatever to do with the maintenance of type. The type is described by the coordinates of the mode. If X_0 be the modal size of any organ in a parent, Y_0 the modal size of the same organ in the offspring, the "type is maintained," or constant, whenever

$$X_0 = Y_0,$$

and this relation is quite independent of the correlation. The correlation between parent and offspring might be absolutely zero, *i.e.* every single parent's offspring might be a fair sample of the whole population, and yet the type might remain absolutely fixed; or, on the other hand, parent and offspring might be perfectly correlated, and yet the type change entirely. This is at least *formally* possible. Thus, in the extreme case of alternating generations A B A B . . ., there might in the statistician's sense be perfect correlation—perfect inheritance—between A and B, although A and B differ absolutely.

Of course in a work of the present kind, written chiefly for drawing attention to the work of others, one does not look for much that is original. There is a curious approximate relation given by the author between geometric mean, arithmetic mean, and standard deviation (p. 38), a relation discovered empirically and given without proof. If

G = geometric mean,
M = arithmetic mean,
σ = standard deviation,

then *approximately* in many cases

$$\sigma^2 = M^2 - G^2.$$

The relation depends solely on all deviations being small compared with the mean, and admits of a simple algebraical proof.

Amongst small points we have marked, we would like the term "individual" variation suppressed, as it is frequently misleading, and surely not equivalent to "spontaneous"; the word "variant" seems to us unnecessary and misleading in the case of continuous variation where arbitrary groupings are used; the distinction between "Rasse" and "Formeneinheit" (p. 17) (". . . erstere nothwendig in mehreren Merkmalen, letztere in einem einzigen differiren") is surely inadequate; a preliminary calculation of the mean before calculating the moments of a frequency distribution (p. 18) is quite unnecessary, as the mean is given by the first moment; and the author is unfortunately in error in ascribing to the present writer (p. 52) the extension of the formulæ of correlation to several variables.

We regret that this notice has had to be for the most part fault-finding, as the author has undertaken a useful and somewhat thankless task, and we believe that, notwithstanding our criticisms, the pamphlet will be useful in extending a knowledge of the statistical method in Germany. There is a bibliography of 111 items at the end of the pamphlet, a feature which will render it useful to English readers as well as German. We are, of course, in sympathy with the author's aim, and hope he may have the opportunity of revising some of the points we have noted in a second issue. G. U. Y.

TEXT-BOOKS OF PHYSICS.

Physics, Experimental and Theoretical. By R. H. Jude and H. Gossin. Pp. xiii + 926. (London: Chapman and Hall, Ltd., 1899.)

THE increasing study of science in schools has been the cause of a considerable crop of text-books of elementary physics, but there is still the want of a more advanced book on the subject. This want Mr. R. H. Jude has endeavoured to supply, and as far as can be judged by a glance through his book, supplemented by a more careful examination of a few chapters, he has succeeded in giving us what promises to be a very useful work both to teachers and students. Experience only can show whether he has hit on the right standard of difficulty, and whether the learner will find the explanations sufficiently clear and complete; but there seems no reason to doubt it, considering that the work is an English adaptation of a book by Prof. Gossin, which is apparently much used in France.

Originally intended to be a translation, the volume before us contains many new articles and chapters, and the translated portions have been amplified. The first volume treats of mechanics, heat and sound. The following remarks are not intended to be special criticisms of this particular book, but rather are suggested by it and put down as matters for consideration, being of general interest to teachers of science.

It seems a little doubtful to me how far a book which contains a somewhat advanced treatment of experimental physics should enter into questions of elementary mechanics. It is impossible to believe that a student who can follow the method of treatment given in the chapters on heat in this volume should not be familiar with the parallelogram of forces, and the construction of the common pump. Some portions of dynamics, such as moments of inertia, must, of course, be included, and it may be argued that it is better to present a complete than a partial statement of mechanical principles. This is true, and of course a good deal might be said about the parallelogram of forces and velocity that is worth reading at any stage in a student's career, but what strikes me in this volume is that the standard of treatment does not quite correspond,

and that a book which enters into questions of entropy and thermodynamic relations might pass a little more rapidly over baby mechanics. This remark applies specially to the illustrations, some of which are of the most elementary character and even childish.

This brings me to the second point I wish to submit to the consideration of authors. A number of illustrations in modern books seem to me to be put in for the sake of interrupting the text by a picture rather than for the sake of explanation. There is, for instance, the usual illustration which pretends to illustrate the fact that all bodies fall in vacuo with the same velocity. A long glass tube with a tap at the lower end, two hands holding it, and about a third of the way downward a small black dot and another dot a little bigger about a millimetre higher up. I suppose that the dots represent bodies, and that their closeness is intended to show their falling together. Unfortunately, in the present instance the stopcock at the bottom is open according to English ideas (though closed if they mean to be French taps), so that the intelligent student unacquainted with the habits of the French plumber would carry away the idea that bodies fall together in air at atmospheric pressure. But without laying stress on this, I should like to know the opinion of my colleagues, whether they seriously believe that students are assisted by illustrations of this nature. Some psychological freak may account for its being so; but it seems odd to me, and is worth investigating. I have marked several other instances of illustrations which seem to me to be of the same type. On the other hand, the diagrams illustrating graphic methods in thermodynamics are clear and well chosen.

Finally, I am not quite sure I like the introduction of exercises and examples. Examinations, no doubt, are a necessity, and I have no objection to books written specially to push boys through them, but the present book is too good to serve in this manner, and one does not quite like being constantly reminded of the fact that ninety-nine per cent. of students only study physics because they are obliged to do so, and I have never yet seen a student, or seen any one to my knowledge who knows a student, who will work through an example without the stimulus of examinations upon him. I should prefer to see the examples collected in a special appendix at the end. Two small points I may draw attention to, as the author may wish to correct them in another edition. Speaking of solar heat, Lord Kelvin's theory of falling meteorites is mentioned, but nothing is said about the now generally accepted theory of Helmholtz that the sun's contraction by his own gravitation is sufficient to account for the keeping up of his temperature.

Speaking of the fact that the surface of liquid at rest is a horizontal plane, the author considers it in § 127 to be a sufficient proof that the image of a plumb line is observed to be a prolongation of the line itself, for it is said that "an object and its image are symmetrical only when the reflecting surface is plain." Will not a spherical surface do equally well, if the plumb line passes through the centre of the sphere? If I add that in the figure on p. 108 the meniscus of a mercury column is wrongly drawn, inasmuch as its curvature diminishes as it approaches the glass sides, I have exhausted all the blemishes which the critical mind can discover. But I started to praise rather than to criticise, and must conclude with the hope that the volumes on light and electricity will soon be ready for publication.

ARTHUR SCHUSTER.

OUR BOOK SHELF.

The Tides Simply Explained: with Practical Hints to Mariners. By the Rev. J. H. S. Moxly, B.A., T.C.D., Chaplain to the Forces; Chaplain to Chelsea Hospital. Pp. viii + 151. (London: Rivingtons, 1899.)

THIS is a paradoxical work which may do harm owing to the standing of its author. He openly avows himself at war with the scientific world:—

"What is this strange hallucination that has taken possession of the minds of great mathematicians? I have quoted several truly absurd statements and arguments of our teachers in my first chapter. I wished to show my readers, by many infallible proofs, that the idols of authority, to which we have been bowing down, are not the correct thinkers we have supposed them to be" (p. 58).

He could not be much more severe if scientific men were a general-staff. His method of "infallible proof" of the fallibility of these idols is simple; he quotes a sentence or a paragraph, and then says:

"This is, of course, sheer nonsense! It is too absurd a statement to deserve any answer" (p. 8).

Having disposed of existing theories by this drastic process, he proceeds to give his own theory of the tides:

"The moon and earth are being drawn together by the attraction of gravity, yet they do not come together. There must therefore be a force equivalent to the force of attraction, but acting in an exactly opposite direction, which keeps the earth and moon asunder. It does not matter what we call it! 'Centrifugal force' will do for a name for it, if you like. The point for us is that the force does exist—must exist, and that it is exactly equal to the attractive force, but opposite in direction. *Well, then, if the attractive force raises a tide under the moon, the force opposite the attractive force will produce a similar effect on the opposite side of the world*" (p. 52).

The sentence in italics (which are mine) is one of the neatest things in paradox I have come across. It is scarcely surprising that the man who could invent it should be able to deduce from this amazing premiss the correct expressions for the tide-generating force at any point on the earth's surface. But then he throws this advantage to the winds, by despising the horizontal component as insignificant, and electing to work with the vertical component only, because it suggests to him an attractive but hopelessly false analogy. We are to imagine a gigantic power taking the world in its grasp, as a schoolboy would squeeze a ball between his finger and thumb. The horizontal component of tide-generating force is compared to a butterfly harnessed to Nelson's Column; but, to suit his own ideas as regards vertical force, Mr. Moxly makes the butterfly a schoolboy and Nelson's Column an india-rubber ball.

After stating this general theory, Mr. Moxly examines some cases of what have been unfortunately called "abnormal" tides, and triumphantly gives explanations of them; partly wrong, and partly such as any one could deduce from a general knowledge of the locality; and, as this is done with some skill, it is to be feared the book may mislead some of the "mariners" to whom it is addressed. It is to be hoped that before trusting Mr. Moxly they will wait until he has produced detailed and successful tide-tables for any given port deduced fairly from his own theories.

H. H. T.

Defective Eyesight. By Dr. D. B. St. John Roosa. Pp. ix + 186. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1899.)

DR. ROOSA'S book is pleasantly written and easy to follow, but it is not very clear what particular place in ophthalmic literature the book is intended to occupy. From the superficial manner in which each subject is treated it would appear to be intended for the instruction of the junior student.

But a student's manual on the refraction of the eye in which no mention is made of retinoscopy, and the ophthalmoscope is only casually referred to as being unnecessary in most refraction cases, is certainly somewhat incomplete.

Most people will agree with Dr. Roosa in condemning the permanent wearing of prisms in the treatment of heterophoria. But the statement that want of balance of the external ocular muscles never causes asthenopic symptoms, is contrary to the experience of the majority of ophthalmologists.

We thoroughly endorse the author's views as to the practical value of the ophthalmometer, though he overstates the case when he says that, to a competent observer, no mistake is possible in the estimation of astigmatism with this instrument. Those who have used both ophthalmometric and other methods with the same patient, in any considerable number of cases, will agree with Adolphe Javal, jun., that corneal astigmatism often differs from the total astigmatism by 0·5 to 0·75 dioptre.

The Lancashire Sea Fisheries. By Charles L. Jackson, M.I.C.E., &c. Pp. viii + 85. (Manchester: Heywood and Son, 1899.)

THIS is a reprint of a lecture delivered in the Chadwick Museum, apparently under the auspices of the Bolton Corporation. It is full of obvious inaccuracies, is hopelessly out of date, and contains on nearly every page cheap sneers at "pure science" and "the scientists," as opposed to the "business" and "practical men." There is a good deal about "Dame Nature" and "Old Ocean," and "the Great Author of the Universe," with whom the author of the book seems to be on curiously confidential terms. This is a work which, if taken seriously, is calculated, we fear, to do much harm—not to the County Council against whose labours it is directed, but to the fishermen in whose interests it professes to be written—by stirring up bad feeling, class prejudices, and opposition to constituted authority.

A Country Schoolmaster, James Shaw, of Tynron, Dumfriesshire. Edited by Robert Wallace. Pp. xcvi + 392. (Edinburgh: Oliver and Boyd. London: Simpkin, Marshall, and Co., Ltd., 1899.)

WE have first a sketch of the life and work of James Shaw; but the bulk of the book is occupied with reprints of some of his more characteristic literary productions. These are upon a great variety of subjects, mostly connected with natural history. The early years of James Shaw's life were spent as a pattern designer and calico printer, and it was not till he was over thirty years of age that he became the schoolmaster at Tynron, a country parish in Dumfriesshire. He continued there for thirty-four years. In the early part of his career his tastes were chiefly literary, and he acquired considerable power as a writer both of prose and verse. After he became a country schoolmaster he devoted himself entirely to natural history and archæology. His papers collected in the present volume are of real interest, and charmingly written. After looking through them we feel the justice of his friend's remark: "Shaw was a large man, fated to play out his life-drama on a small and dimly-lighted stage."

LETTER 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.*]

Apparent Dark Lightning Flashes.

LAST night during a thunderstorm of rare severity in which brilliant flashes—single, double, triple, or quadruple—followed one another at intervals often of not more than a few seconds of time, I was surprised to see with great vividness, on a suddenly illuminated sky, two nearly vertical lines of darkness, each of the ordinary jagged appearance of a bright flash of lightning. I remembered to have seen two real flashes of just the same shapes and relative positions, and I concluded that the black flashes were due to their residual influence on the retina. I turned my eyes quickly from the dark sky outside to an illuminated wall inside the house, and I again saw the same double dark "flash," which verified my conclusion in an interesting manner. The fatigued part of the eye failed to perceive the sudden brightness of the sky in the one case and of the wall in the other.

Aix-les-Bains, August 7. KELVIN.

MEETING OF THE BRITISH MEDICAL ASSOCIATION AT PORTSMOUTH.

A GOODLY number of members of this pre-eminently practical Association journeyed last week to Portsmouth to be present at the sixty-seventh annual meeting. The place of meeting was not so attractive as last year, and perhaps on this account the attendance was somewhat smaller. The subject-matter, however, at Portsmouth was quite as interesting as that at Edinburgh; and those who, braving almost tropical heat, were diligent in their attendance at the meetings got their reward, and will return home with ample food for thought.

After an eloquent and interesting address from the President, Dr. Ward Cousins, in which a sketch was given of the progress made in medicine and surgery during the present century, the meeting divided itself up into sections, and settled down to work.

Section of Medicine.—An address on medicine was delivered by Sir Richard Douglas Powell, his subject being recent advances in practical medicine. Under this heading various points of practical interest were discussed. The use of the binaural stethoscope received some attention, the author somewhat deploring the decadence of the old rigid stethoscope, a flexible instrument being incapable of transmitting tactile impulses. Under the head of "Anomalous Fevers," Sir Richard discussed shortly the important subject of mixed infection. The value of what was said on serum therapy was enhanced by the addition of a table indicating the actions of the various sera. Under the "Prevention and Treatment of Tuberculosis" the vexed question of the influence of heredity was considered, the author apparently attaching more importance to this influence than recent investigations would seem to justify. The address concluded with a few suggestive hints concerning a possible pre-parasitic existence of the tubercle bacillus.

At the opening of the section, the President, Dr. Mitchell Bruce, made a few introductory remarks with regard to the subjects of discussion, viz. the tests for admission into the public services, and Tuberculosis. Sir Dyce Duckworth's paper upon the former subject, in his unavoidable absence, was read by the President. The paper comprised a valuable critique of the methods of examination at present adopted by the public services, and a consideration of the causes and rejection of defective candidates. An animated discussion followed this paper. Prof. Osler advocated that the physical examination of candidates should take place earlier in the course of their training, and alluded to the more common causes of, according to him, unnecessary

rejection. Dr. Wallace discussed the matter from a civil standpoint, and advised the forming of a definite standard of physical fitness. Dr. W. Turner drew attention to the mental condition of candidates, and to the not uncommon occurrence of insanity during active service. The result of the discussion was that the following resolutions were sent up to the Council with a request that they be submitted to the War Office: (1) That the physical examination should precede the educational; (2) that soldiers should not serve in the tropics till twenty-two; (3) that the question of the physical standard should receive reconsideration.

A number of papers, which provoked some discussion, upon the ever-present subject of uric acid and gout followed.

Section of Surgery.—An address in surgery was delivered by Dr. Ogston, the medical services of the army and navy forming the subject. The author dealt at length with the unsatisfactory condition of the services, both from the point of view of the medical man and the soldier. During the last three decades the class of medical man aspiring to enter the services has very much depreciated, a fact greatly to be deplored. Further, the medical services are undermanned, and there is a want of adequate training. The Indian Medical Service is, to some extent, an exception, and offers many more advantages than the army and navy. The author indicated generally some lines of remedy for the present regrettable condition of the medical services, and contrasted the methods used by the authorities here with those used abroad, notably in Germany, Russia and France.

The president of the section, Mr. Butlin, delivered a short address on the work of the section. The two special subjects for discussion in this section were (1) the diagnosis and treatment of gunshot wounds of the abdomen, and (2) the prevention and treatment of syphilis in the army and navy.

Section of Obstetrics and Gynaecology.—The President of this section, Dr. Granville Bantock, delivered an address in which he urged that in gynæcological cases a more conservative attitude might be adopted, and that a diminution in the number of operations performed might with benefit to the patients take place.

An interesting discussion subsequently took place upon fever following delivery, with special reference to serum therapy. The discussion was opened with a paper by Dr. Herbert Spencer. With regard to the serum treatment the author remarked that a large number of observations had now been made upon this subject, 350 cases having been collected by a committee of the American Gynæcological Society. Among these cases there was a mortality of 33 per cent., but the natural mortality of the diseases was probably not greater than this. Little more can be said for this treatment in this class of case than that it somewhat ameliorates the severity of the disease.

Section of State Medicine.—Dr. George Wilson delivered the presidential address in this section. The author discussed the relation of bacteriological research and methods to preventive medicine.

Section of Psychology.—Dr. Nicolson dealt with the interesting question of the reproachable differences of medical opinion in lunacy cases, and whether they could be avoided. Differences of opinion among medical men were not uncommon in (1) ordinary lunacy cases, (2) civil cases, (3) non-capital criminal cases, and (4) capital criminal cases. In the case of criminal cases, malingering formed a most puzzling element. The author laid stress upon the fact that, although anthropological measurements afforded very valuable information and were to be encouraged as likely in the future to be capable of formulating rules of value, too much stress with regard to individual cases should not be placed upon them. An active discussion followed this paper.

Section of Anatomy and Physiology.—The presidential address in this section was delivered by Dr. Charles. The lecturer dealt with the advancement which had recently been made in physiology. He noticed with pleasure that now in this country physiology numbered amongst her votaries a number of accomplished organisers and able laboratory workers, and that we had not now to reproach ourselves with neglecting what Du Bois Reymond rightly called the queen of the natural sciences.

Mr. Stanley Boyd read a paper on the interaction between the ovaries and the mammary glands. This interaction, he remarked, in the cases of removal of both ovaries caused an apparent subsidence and retrogression of cancerous growths in the breast.

Section of Pathology.—Dr. Payne delivered the presidential address in this section. A discussion followed upon ulcerative endocarditis.

Section of Pharmacology and Therapeutics.—The President, Dr. Bradbury, in opening the work of this section, referred to the difficulty in fixing the place of pharmacology in the medical curriculum. He considered an accurate knowledge of pharmacology to be essential to the practitioner of medicine.

The work of the section began with a paper by Dr. Lauder Brunton on headaches. The paper contained a mass of valuable and interesting information, and comprised a consideration of the *rôle* played by vaso-motor changes in the causation of headaches, and also that played by toxæmic conditions and errors of refraction. The treatments of the different forms of headache were considered, and many useful hints as regards their prevention were given. A discussion followed. Upon replying, Dr. Brunton mentioned that altitudes and depths probably produced headaches by altering the atmospheric pressure in the sinuses.

Section of Laryngology and Otology.—The President, Mr. Creswell Baber, delivered an address on the progress of rhinology during the last thirty years.

The section of Tropical Diseases was well attended. Dr. George Thin gave an able address, in which he referred to recent researches on the extra corporeal life of the malarial parasites. The President, after having regretted the unavoidable absence of Major Ross, began to discuss the teaching of tropical medicine. The author dwelt at some length upon the advantages of Netley as affording more material than any other institution for the teaching of tropical medicine, and showed diagrams comparing Netley with London and Liverpool as regards the number of patients available for instruction. According to the author, the advantages possessed by Netley were very great, especially with regard to hepatitis and hepatic abscess.

The museum of the Association, always a prominent feature of the annual meetings, was well filled with exhibits, and was much patronised by members.

Nunquam animus motu vacuus est. Absolute rest is a myth of the consulting room often prescribed but rarely practised. It, along with the Salisbury diet and other things, is what one expects of one's friends but not of oneself. The hard-working medical man doubtless wants absolute rest badly enough, but by prefixing his holiday with an attendance at the annual British Medical Association meeting he acts wisely. There work is so mixed up with pleasure that one passes almost insensibly from the one to the other, the meetings forming as it were an intermediate region between work and holiday, shading off the contrast between the two, making the loss of constant occupation less acute, and helping one to slip easily into the *dolce far niente* which one has earned so well.

F. W. TUNNICLIFFE.

THE RELATION OF MOTION IN ANIMALS AND PLANTS TO THE ELECTRICAL PHENOMENA ASSOCIATED WITH IT.[1]

THE lecturer began by observing that the proper subject of the lecture being "the nature or laws of muscular motion,"[2] he would discuss the chemical, mechanical and electrical concomitants of this most important function with a view to the elucidation of their mutual causal relations. He would, however, ask the attention of the Society chiefly to the *electrical* phenomena which are associated with muscular action, as being those which he had himself specially studied. Some points relating to the *mechanical* effects of muscular action must be referred to by way of introduction, inasmuch as it is by these that a muscle performs its function as an organ of motion. There were two ways of investigating these effects experimentally. We might observe and record either the change of form which a muscle undergoes in response to a stimulus of very short duration when contracting isotonically, *i.e.* as it does when lifting a weight, or the increase of tension which occurs when it endeavours to overcome a resistance, *i.e.* when it acts isometrically. It was shown that although, as regards an entire muscle, the isometric method was preferable to the isotonic, the time occupied by a single element of muscular structure when directly excited in developing its maximum tension (*i.e.* in the transformation of chemical into mechanical energy) could be best estimated under isotonic conditions. He then proceeded to describe his own method of accomplishing this measurement with the aid of photography. It consists in observing the change of form of the surface of a living muscle when a single break induction current is led through it in such a way that the observed surface is at the kathode. A magnified image of the kathodic electrode, which moves freely with the muscle, is projected on a slit behind which a sensitive plate passes, and in this way a curve is obtained from which the time-relations of the movement can be deduced. It is thus learned that at the kathodic spot, *i.e.* at the spot immediately excited, the process attains its greatest activity before the end of the first hundredth of a second. The importance of this datum consists in its bearing on the question whether or not the electrical change by which the change of form thus observed is accompanied is coincident with it, follows or precedes it. The answer to this question could not, of course, be given until the time-relations of the electrical change had been considered. These were discussed as follows :—

The essential point in investigating the *electrical* changes which occur in muscle is to connect two parts of its surface through a galvanoscope. The general result of such an exploration is (1) that similar parts in a similar physiological state are equipotential ; (2) that between similar parts which are not in the same state there is always a difference of potential, measurable by the method of compensation, the less capable of function, *i.e.* the less living, being negative to the more living ; and (3) that transitory differences of potential arise between two parts of the living surface when the one is excited to discharge of function, the other remaining at rest. Thus the state of rest or fitness for function of a part is denoted by relative "positivity," discharge of function by relative "negativity."[3]

[1] Abstract of the Croonian Lecture, delivered before the Royal Society, by J. Burdon-Sanderson, M.A., M.D., F.R.S., on March 16.

[2] See "The Record" of the Royal Society, 1897, p. 126.

[3] The use of these words in the sense above stated has been strongly objected to. It is difficult to see to what obscurity of meaning it can give rise. "Negativity" of a surface means nothing more than it is negative *relatively* to another surface.

First Fundamental Experiment.—The effect of an excitation which is instantaneous and so localised as to affect in the first instance only one of the two surfaces of contact is the sudden manifestation of a difference of potential between them, this effect being momentary (case 1) or continuous (case 2) according to the duration of the excitation. In either case it is designated "excitatory variation" if the muscle is referred to, *or* "action current" if the galvanoscope is referred to.[1] If the capillary electrometer is used as galvanoscope, and its excursions are recorded photographically, the curves so obtained truly and faithfully express to us the character and time-relations of the *variation*, provided only that we know according to what rule they are to be interpreted. This rule can be deduced from the well-known properties of the instrument, as has been fully set forth elsewhere.[2] We may, however, interpret the photographic curves we obtain in the exploration of living muscle by *comparing* them with counterparts photographed under previously determined and known physical conditions. Thus by arranging our physical experiment so as to reproduce the hypothetical conditions of our physiological one, we may prove the truth of our hypothesis by the coincidence of the two results. And inasmuch as the two cases, *i.e.* the two forms of "variation," above referred to, are the only ones that present themselves, provided that we adopt a mode of procedure to be presently explained, there is no difficulty in applying this purely empirical procedure.

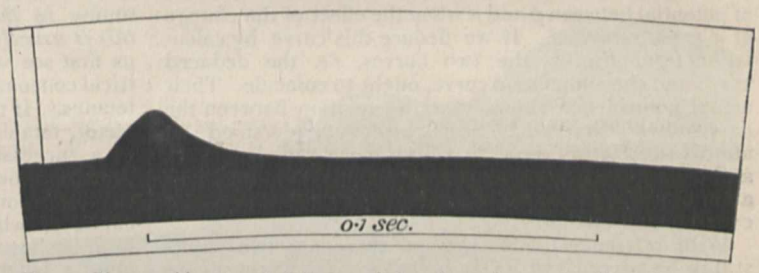
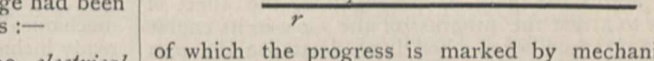


FIG. 1.—Photographic curve of diphasic variation of sartorius muscle. Rate of movement of plate indicated by distance accomplished in 1/10 sec. ; moment of excitation by vertical (radial) line.

The first fundamental experiment is one in which a curarised muscle of simple structure (*i.e.* one which consists of a band of parallel fibres) is subjected to the action of an instantaneous stimulus applied to it near one end, as shown below. The result is that a wave of excitation,



of which the progress is marked by mechanical and electrical changes, passes along each fibre (represented by the black line), starting from the seat of excitation *r*, and affecting first the nearest contact *p*, and after an interval the more distant contact *d*. The photograph (Fig. 1) is the curve obtained under these conditions. But if, as above suggested, we proceed in such a way as to limit the observation to what happens at one contact only, and for this purpose *cancel* the effect at the further contact *d*, and repeat our photographic observation just as before, we find that the curve has assumed an entirely different form shown in the photograph (Fig. 2). [As in both photographs, the movement of the sensitive plate is circular, the ordinates are polar, and must be measured accordingly.] Before the effect at *d* was cancelled, the curve had the form shown in Fig. 1. We therefore conjecture that the

[1] Here again our language has been objected to. "Excitatory variation" means the coming into existence of a difference of potential between two surfaces in consequence of stimulation of one or both of them. It is a translation of the German word "Reizschwankung."

[2] *Journal of Physiology*, xxiii. p. 325.

difference of contour between Figs. 1 and 2 represents the effect of the arrival of the wave of excitation at the distal electrode *d*. The proof that this is so is as follows (see diagram, Fig. 3):—From the measurement of the polar ordinates of Fig. 1 we obtain by calculation the curve P′, which represents the change which occurs in the

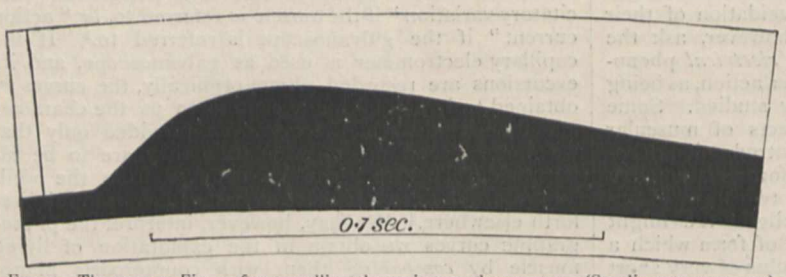


FIG. 2.—The same as Fig. 1 after cancelling the excitatory change at D. (See diagram on p. 343.)

difference of potential between the surface of contact *p* and the rest of the surface of the muscle during the period of excitation.[1] We assume an identical curve D′ in the same relation to the contact *d*, differing from P′ only in the opposite sign of its ordinates, and relating to a period a little (in the case represented 15/1000 sec.) later than of P′; and by summing the synchronous ordinates of the two curves P′ and D′ algebraically, we obtain the curve S′, which expresses what must be the successive differences of potential between *p* and *d* when the effect of the change at *d* *is not cancelled*. If we deduce this curve by calculation from Fig. 2, the two curves, *i.e.* the deduced curve and the summation curve, ought to coincide. Their actual coincidence shows that the relation between the curves P′, D′ and S′ has been correctly understood; it affords satisfactory proof that from P′ we can deduce S′, and consequently good reason for making the determination of P′, *i.e.* the *monophasic variation*, the aim of our experimental method.

With reference to this method there are two points still to be adverted to. One is that it gives us the means of measuring with great exactitude the rate of propagation of the "excitatory wave," the progress of which from the seat of excitation has been already mentioned, and of proving that, although it varies according to the temperature and the vitality of the muscle, it is, under unchanging conditions, fairly constant. The other point relates to the mode of cancelling the effect of the wave of excitation at the distal electrode. The most effectual and simplest way of doing this is to apply a tight ligature across the path of propagation, the effect of which is to arrest the progress of the wave in its course from *p* to *d*. Another method is to devitalise the part of the muscle to which the distal electrode is applied by heat. The result in the two cases is the same as regards the electrical response to excitation. Fig. 1 is converted into Fig. 2. But as regards the electrical state of the muscle when at rest it is different—*i.e.* when the ligature is applied half-way between *p* and *d* the contacts remain equipotential, or nearly so; whereas in the other case the unexcited and unexcitable dead surface is found to be strongly negative to the other.

We are now in a position to sum up what is to be learned from the first fundamental experiment. The most important result is that, both as regards the muscle when "at rest" and the change of state which is evoked by excitation, the observed instrumental effect depends exclusively on the state of the surfaces of contact, and consequently, when the distal contact is cancelled, on that of the proximal contact only.

Second Fundamental Experiment.—We have so far only considered experimentally the effects of a single instantaneous excitation on muscle, causing it to give the mechanical effect known as a twitch. We have now to inquire what are the electrical concomitants of *continuous contraction*. This part of the subject has greater interest than the one we have been considering, inasmuch as it involves the question of the nature of ordinary voluntary muscular action, with reference to which there are reasons for holding that its continuity is apparent only. One of the chief of such reasons is to be found in the supposed resemblance of the sound of a muscle contracting normally to the musical sound of a muscle subjected to a rapid series of instantaneous stimuli. It is ordinarily stated that inasmuch as we can produce continuous contraction by discontinuous stimulation (artificial tetanus), all continuous contraction is so produced. Putting aside the question of muscle-sound, which does not here concern us, and confining ourselves to the electrical concomitants of continuous action, it can be shown that under certain conditions a continuous effect can be evoked by a single uninterrupted stimulus, and that in the nearest approach we can get to natural contraction, the reflex spasm, there is no evidence of discontinuity *in the sense in which this is usually understood*. Let us first see what are the electrical concomitants of artificial tetanus. If the muscle is completely tetanised, *i.e.* subjected to a succession of stimuli at the rate of over 50 per second, the electrometer gives us a curve, of which the general form is shown in Fig. 4. The muscle passes at once from the state of *capacity for action* into the state of *action*. This is indicated by the sudden manifestation of a difference of potential, which persists as long as its cause.

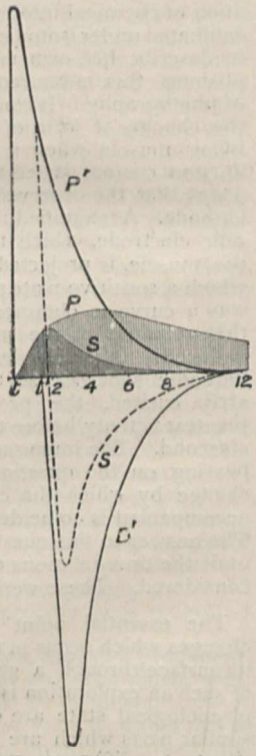


FIG. 3.—Diagram showing the relation between the photographic curves and the curves of difference of potential which they indicate and between the monophasic curves P′ and D′ and the diphasic S′. The numbers below the horizontal line denote hundredths of a second.

When the rate of excitation is less frequent, the electrometer curve gives evidence that the tetanus, whether still mechanically complete, or already incomplete, is composed of a series of twitches, *i.e.* of single monophasic effects. [Photographs were shown of the response in a sartorius, devitalised under the distal electrode, and excited by a series of instantaneous stimuli following each other with a frequency of 60 per sec. in one case, 20 per sec. in the other.]

If, however, while still retaining the higher frequency, we subject the muscle to a series of short tetanising excitations, each lasting say for a tenth of a second or more, and succeeded by a rest of similar duration, we obtain a curve of alternate polarisation and depolarisation such as would represent short, but persisting, differences of potential, alternating with periods of indifference (Fig. 5).

[1] The way in which the curve P′ is deduced is fully given in the paper quoted above in the *Journal of Physiology*, vol. xxiii.

The Reflex Spasm.—We may now pass to *reflex action*, in which, since the motor apparatus of the cord has to be first excited through a sensory nerve, the time which elapses before a response is evoked is necessarily longer than in the cases we have been so far considering. The

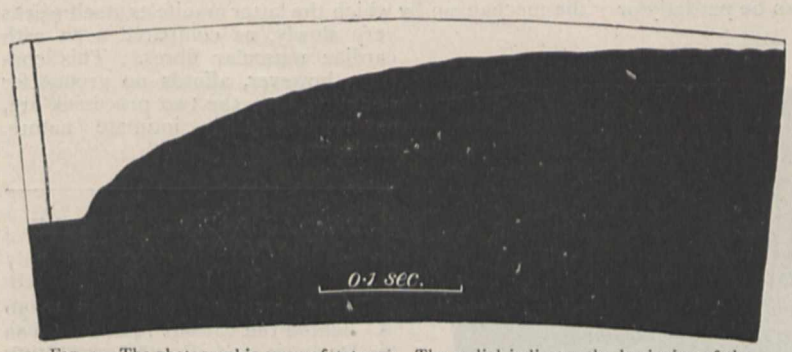


FIG. 4.—The photographic curve of tetanus. The radial indicates the beginning of the period of excitation.

response, if the motor cells of the cord have been rendered extra sensitive by a minute dose of strychnine, is a prolonged contraction [tracing of mechanical effect shown] the graphic of which is often indistinguishable from that of complete tetanus. When the electrical concomitants of such a spasm are recorded photographically (Fig. 6), it is seen that the curve resembles rather that of complete tetanus interrupted at regular intervals, than that of a series of responses to single instantaneous stimuli following each other at intervals of a tenth of a second or more. And by analysing the curve we learn that the difference which in the first instance comes into existence between the contacts, disappears and reappears rhythmically, and finally ceases. A single stimulus to the motor cells of the cord has therefore produced a series of short prolonged responses in the muscle, of which the rhythm is *central*, not muscular. The motor cell pours its influence on the muscle at regular intervals, but its effect each time is that of a continuous action.

The property which a muscle has of, under ordinary experimental conditions, relaxing as soon as the exciting

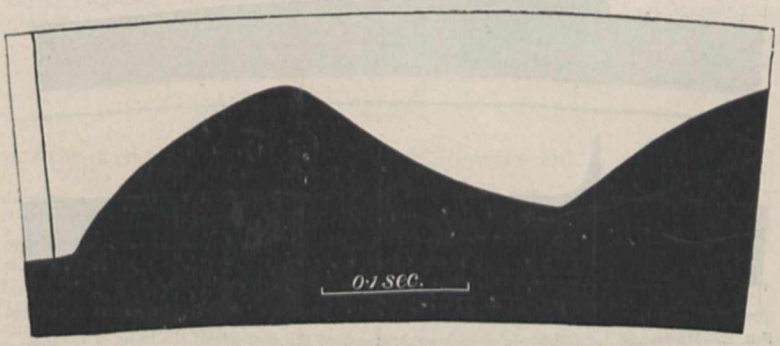


FIG. 5.—Tetanus of short duration, followed by another after an interval during which the muscle was not excited.

cause ceases, appears at first to indicate discontinuity of voluntary action. We have, however, a means of removing this property without materially impairing the functional capacity of the muscle. This means is furnished by the alkaloid *veratrine*. So long as this is used in sufficiently small quantity ($\frac{1}{10000}$ mgr. to a sartorius), its effect consists chiefly in the annulling of the unknown inhibitory mechanism, by virtue of which a muscle, after having responded to an instantaneous stimulus, at once returns to its previous state. Under the influence of veratrine, when once started to work it is compelled to go on. [It was shown by graphic records that a muscle so treated can do as much work in response to a single instantaneous stimulus, whether in lifting heavy loads or in producing tension, as a normal muscle subjected to a series of instantaneous stimuli.] The electrical phenomena evoked by a single stimulus in a veratrinised muscle likewise show that the effect is absolutely continuous; there is no trace of unevenness or undulation in the photographic curve (Fig. 7), the contour of which resembles the general contour of artificial tetanus, *i.e.* a sudden difference of potential comes into existence at the moment of excitation, but, notwithstanding that it is evoked by an instantaneous stimulus, it persists as if it were the response to a continuous one.

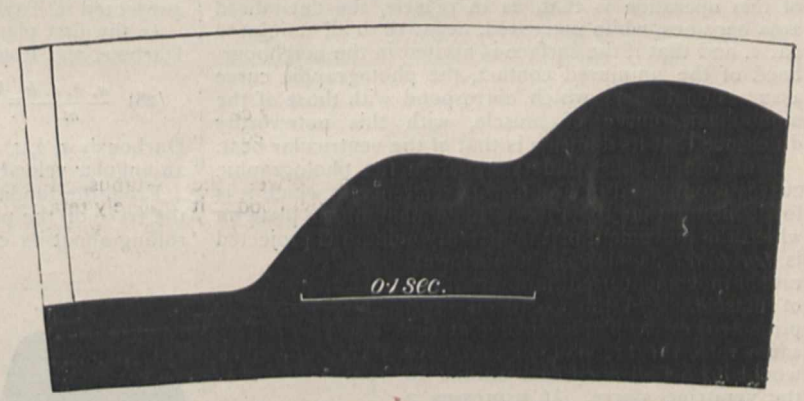


FIG. 6.—Reflex response of sartorius to instantaneous excitation in strychnised preparation.

To complete the subject, it is necessary to describe the electrical phenomena which accompany the action of the heart. In all that has preceded, a parallel-fibred muscle has been employed in which the excitatory wave is propagated along the fibres in two opposite directions only. In the heart the fibres are short, and run in all directions. The wave of excitation may originate anywhere, and may spread in any direction. We employ the ventricle of the heart of the frog, having first arrested its rhythmical beat by a ligature between sinus and auricle. We can then evoke a contraction by an instantaneous excitation at any part of its surface, and thus imitate the first fundamental experiment in muscle. At the excited point the surface becomes instantly negative to all other parts, and the state of relative negativity spreads radially just as in muscle it was propagated longitudinally, the electrical effect appearing to precede the mechanical. Moreover, the duration of the process is ten times as long, and the rate of propagation ten times as slow. But in other respects the two processes in cardiac and skeletal muscle

are so analogous, that if the distance of the contacts, the duration of the change at the seat of excitation (monophasic variation), and the rate of propagation are known, it is easy to forecast the curve of the diphasic variation.

By a similar method to that employed in the study of muscle, the effect at the distal contact can be partially or entirely cancelled. All that is necessary is to destroy by heat the surface under the distal electrode. The result of this operation is that, as in muscle, the devitalised area becomes, while unexcited, negative to all uninjured parts, and that if the surface is excited in the neighbourhood of the uninjured contact, the photographic curve assumes characters which correspond with those of the monophasic curve of muscle, with this noteworthy difference that its duration is that of the ventricular beat.

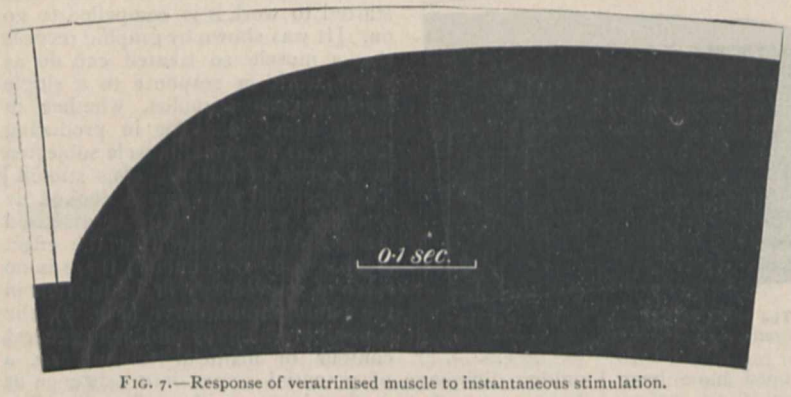


FIG. 7.—Response of veratrinised muscle to instantaneous stimulation.

This can be best understood from the photographic curves reproduced in Fig. 8, with reference to which it is to be noted that the rate of movement of the plate on which the movement of the mercury column is projected is *ten times* as slow as the slowest rate of movement used in observations of muscle. Had the excursion been projected on a plate moving at the same rate, the first half of the curve would have had a contour similar to the veratrine curve. It expresses a sudden coming into existence of a difference of potential between the two contacts which may be maintained (in the heart) for more than two seconds.

In the second curve of Fig. 8 the curve begins as in the first, but the effect on the electrometer of the change which is taking place at the proximal electrode is immediately afterwards counteracted and balanced by the similar change at the distal contact, and is followed by a period of indifference, the end of which is marked by a descent of the column. This (as was explained by the lecturer many years ago) means that the effect at the distal electrode over-lasts that which occurs at the proximal.

The lecture concluded with a comparison of the electromotive properties of the leaf of the fly-trap with those of muscle. If the same method of exploration is applied to the surface of the leaf as to the ventricle of the heart of the frog, it is easy to show that the phenomena observed after excitation in the two structures are essentially analogous. In both an electrical change is the immediate result of a localised instantaneous excitation, and this change spreads from the excited spot to parts at a distance at a rate which varies with temperature. The interval of time between the culmination of the electrical response and that of the change of form is much more obvious in the leaf than in the heart, because the mechanism by which the latter manifests itself works very slowly, as compared even with cardiac muscular fibres. This contrast, however, affords no ground for doubting that the two processes are, as regards their intimate nature, analogous.

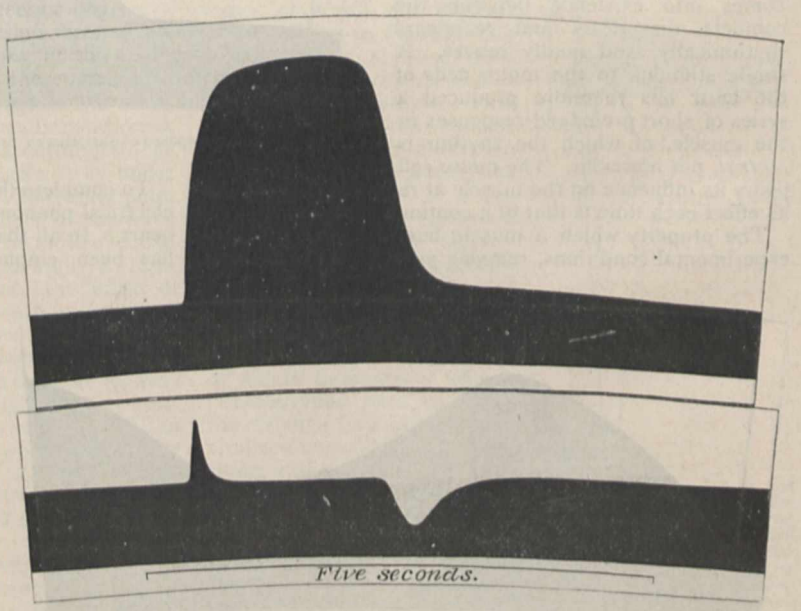


FIG. 8.—Monophasic and diphasic photographic curves of the ventricle of the heart of the frog.

MATHEMATICS OF THE SPINNING-TOP.[1]

II.

IT is instructive at this stage to go behind the various relations given by Darboux and Routh, connecting A, B, C, D, and δ, and the accented letters, and to examine their inner geometrical significance; various interesting theorems of Geometrical Conic Sections will be required, which will show the practical utility of the study of this elegant subject, as presented in Taylor's "Geometry of Conics."

In the first place we can connect up the notation of Darboux and Routh by taking

$$(28)\quad \frac{a, b, c, h}{m} = \frac{HV, HT, HP, HQ}{OD} = \left(\frac{D}{A'}, \frac{D}{B'}, \frac{D}{C'}, 1\right)\frac{HQ}{OD},$$

Darboux's a, b, c, h being of the same dimensions as m, an angular velocity estimated in radians/second.

From the fundamental property of the herpolhode as the trace of the points of contact of a quadric surface, rolling about its centre O on a fixed plane GH, namely, that the radius vector GH and the tangent HK are conjugate on the rolling surface, combined with the properties of conjugate diameters, we can deduce the

[1] "Ueber die Theorie des Kreisels." F. Klein und A. Sommerfeld. Heft i, ii. Pp. 196 and 197 to 512. (Leipzig: Teubner, 1897-8.) (Continued from p. 322.)

analytical theorems of the curve. Thus, if OE and OF are the conjugate diameters parallel to the tangent HK and the vector GH, and if OK is the perpendicular on HK, then, with Darboux's notation,

$$a+b+c=\mathrm{P},\ bc+ca+ab=\mathrm{Q},\ abc=\mathrm{R},$$

and putting

$$\frac{\mathrm{OG}^2}{\mathrm{OD}^2}=\frac{h}{m},$$

$$(29)\qquad \frac{\mathrm{OE}^2+\mathrm{OF}^2+\mathrm{OH}^2}{\mathrm{OD}^2}=\frac{\mathrm{P}}{m},$$

$$(30)\qquad \frac{\mathrm{OE}^2\,.\,\mathrm{OF}^2\sin^2\mathrm{EOF}+\mathrm{OK}^2\,.\,\mathrm{OE}^2+\mathrm{OF}^2\ \ \mathrm{OG}^2}{\mathrm{OD}^4}=\frac{\mathrm{Q}}{m^2},$$

$$(31)\qquad \frac{\mathrm{OG}^2\,.\,\mathrm{OE}^2\,.\,\mathrm{OF}^2\sin^2\mathrm{EOF}}{\mathrm{OD}^6}=\frac{\mathrm{R}}{m^3}.$$

The elimination of OE^2, OF^2, and $\sin^2\mathrm{EOF}$ between these equations gives the relation connecting OH^2 and OK^2 in the herpolhode; it is linear in OK^2 and quadratic in OH^2. The geodetic radius of curvature of the polhode on the polhode cone is readily found by a differentiation by exactly the same formula as the $rdr/d\phi$ formula of a plane curve; and the radius of curvature of the herpolhode in the plane of G is the projection of this geodetic radius of curvature.

At a point of inflexion on the herpolhode this geodetic radius of curvature is infinite, and now the polhode is a bit of a geodesic on the polhode cone; this shows that the osculating plane of the polhode is now perpendicular to OK.

But to find whether the herpolhode can have points of inflexion, we merely require to find where the value of OK is stationary, and this is found by solving the quadratic in OH^2, and examining its discriminant; in this way we shall find that the discriminant vanishes, and OK is at a turning point, when

$$(32)\qquad m\frac{\mathrm{GK}^2}{\mathrm{OD}^2}=0,\ \text{or}\ \frac{4(a-h)(b-h)(c-h)\mathrm{R}}{\Omega^2 h},$$

where, in Darboux's notation,

$$\Omega^2=\mathrm{Q}^2-4\mathrm{R}(\mathrm{P}-h).$$

The value GK = 0 is excluded when the rolling surface is an ellipsoid; it will be found that the other value makes

$$m\frac{\mathrm{OF}^2}{\mathrm{OD}^2}=\frac{\mathrm{Q}}{2h},$$

$$m^2\frac{\mathrm{OF}^2\,.\,\mathrm{OG}^2}{\mathrm{OD}^4}=\tfrac{1}{2}\mathrm{Q};$$

and the maximum value of this being ab, it follows that

$$ab-\tfrac{1}{2}\mathrm{Q}=\tfrac{1}{2}\mathrm{R}\left(\frac{1}{c}-\frac{1}{a}-\frac{1}{b}\right)=\frac{1}{2}m^2\frac{\mathrm{HQ}^2}{\mathrm{OD}^2}\frac{\mathrm{D}^2}{\mathrm{ABC}}(\mathrm{C}-\mathrm{A}-\mathrm{B})$$

is positive, so that the rolling quadric cannot be the momental ellipsoid of real positive matter for points of inflexion to exist, in accordance with the theorems of Hess and de Sparre.

Fig. 1 has been drawn with the idea at first of giving the graphical representation of the numerical case discussed in VI. § 6; so that

$$f=\frac{a-b}{\omega'}=-0{\cdot}0068,\quad f'=\frac{a+b}{\omega'}=1{\cdot}421$$

(these numbers appear to show that s and s' on p. 481 must be interchanged).

But as these numbers bring the point P inconveniently near to A, fresh dimensions are chosen; we can take a scale such that OA = 10 cm., OB = 5, so that κ is reduced from 0·521 to 0·5; and the points P and P′ were so placed as to make $\theta_2=45°$, $\theta_2=30°$; and now, by measurement, OD = 17·73 cm.,

HQ = 16·4 cm.	HQ′ = 8·9 cm.
HT = 5·4 cm.	HT′ = 21·6 cm.
HV = 15·0 cm.	HV′ = 8·3 cm.
HP = 6·2 cm.	HP′ = 10·4 cm.

The angle AOQ or $\omega=33°$ by measurement, so that from Legendre's Table IX., to the co-modular angle 60°,

$$\mathrm{F}\omega=0{\cdot}6009,\quad \mathrm{K}'=2{\cdot}1565,$$
$$\mathrm{E}\omega=0{\cdot}5528,\quad \mathrm{E}'=1{\cdot}2111;$$

and thence

$$f=-0{\cdot}2787,$$

and

$$\mathrm{QL}=2{\cdot}153\ \text{cm.}$$

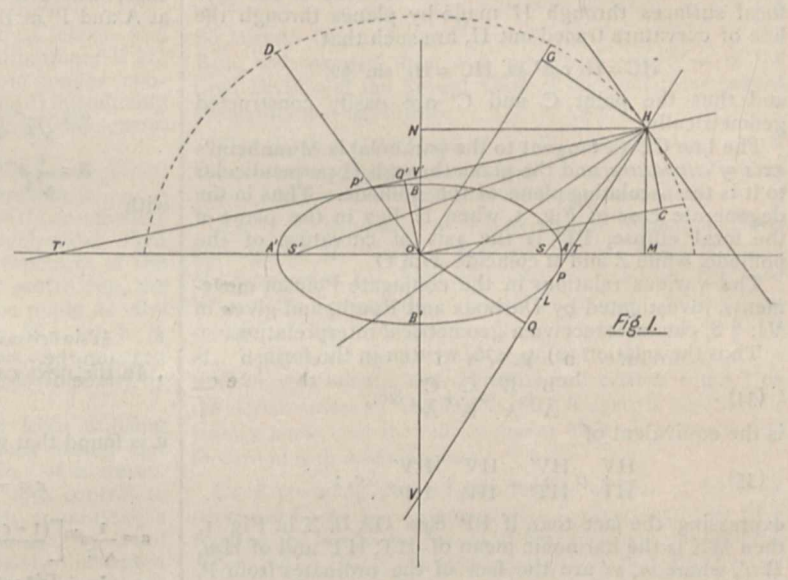


Fig. 1.

Thence the apsidal angle, as a fraction of a right angle, is given by

$$(33)\qquad \frac{\Psi}{\frac{1}{2}\pi}=\frac{\mathrm{HL}}{\mathrm{OA}}\frac{\mathrm{K}}{\frac{1}{2}\pi}+f=1{\cdot}245.$$

As θ diminishes from θ_3 to θ_2, the deformable hyperboloid opens out from the plane of the focal ellipse and flattens again in the plane of the focal hyperbola. As a typical intermediate position choose that of half-time; with our dimensions this will make

$$\sin^2\phi=\frac{1}{1+\kappa'}=0{\cdot}5359,$$
$$\cos\theta=0{\cdot}792,\ \theta=37°\ 37'.$$

Project the figure on to the plane of the generating lines HQ, HQ′, which are now drawn inclined at 37° 37′, and place the points Q, T, V, P, &c., on these lines as before; the confocal quadrics project into confocal conics.

The lines TT′, VV′, PP′ form a triangle XYZ, the sides of which are the traces of the principal planes: Ω, the orthocentre of this triangle, is the projection of the origin O.

We must be content with the mere statement of the following geometrical theorems, required for throwing light upon the analytical theorems of this dynamical problem, with a view of obtaining a clear image of the motion in accordance with Poinsot's ideas; the demonstrations will be found in Salmon's "Solid Geometry,"

or better still, in Mannheim's "Géométrie Cinématique," which has been found valuable in carrying on the Poinsot traditions of dynamical presentation.

Join HΩ, cutting the sides of the triangle XYZ in α, β, γ; describe the circle round XYZ, and let XΩ, YΩ, ZΩ cut this circle in d, e, f; then $ad, \beta e, \gamma f$ intersect the circle in one point F. F is the focus, and HΩ the directrix of the parabola, which is the envelop of the normals of the confocals (Salmon, "Solid Geometry," § 177); this parabola touches the sides of the triangle XYZ; the tangents to the parabola from H are tangents to the projections on the plane of the confocals through H, while the tangents to the parabola from Ω are the axes of these plane confocals; also HΩ and HF are equally inclined to HQ and HQ′.

If Hc, Hc' are the tangents to the parabola from H, the points of contact c and c' are the centres of curvature of the plane confocals through H; while C and C′, the centres of curvature of the normal sections of the confocal surfaces through H made by planes through the line of curvature traced out H, are such that

$$HC = Hc\cos^2\tfrac{1}{2}\theta,\ HC' = Hc'\sin^2\tfrac{1}{2}\theta,$$

and thus the point C and C′ are easily constructed geometrically.

The line CC (a tangent to the parabola) is Mannheim's *axis of curvature*, and the plane through H perpendicular to it is the osculating plane of the polhode. Thus in the degenerate case of Fig. 1, when H lies in the plane of the focal ellipse, PP′ is the axis of curvature of the polhode, while Z and Ω coincide with O.

The various relations in the conjugate Poinsot movements, investigated by Darboux and Routh, and given in VI. § 8, can now receive a geometrical interpretation.

Thus the relation (2), p. 476, written in the form

$$\frac{B}{A}+\frac{B'}{A'}=\frac{C}{A}+\frac{C'}{A'},\ \&c., \tag{34}$$

is the equivalent of

$$\frac{HV}{HT}+\frac{HV'}{HT'}=\frac{HV}{HP}+\frac{HV'}{HP'},\ \&c.; \tag{35}$$

expressing the fact that, if PP′ cuts OA in X in Fig. 1, then MX is the harmonic mean of HT, HT′ and of Hm, Hm', where m, m' are the feet of the ordinates from P, P′ on OA.

Again, if XΩ meets YZ in D, then OD and OV are conjugate diameters in the principal plane OYZ of the rolling quadric

$$\frac{x^2}{HV}+\frac{y^2}{HT}+\frac{z^2}{HP}=HQ, \tag{36}$$

and therefore

$$\frac{HP}{HT}=\tan YOD\tan YOV=\frac{VY}{VZ};$$

similarly

$$\frac{HV}{HP}=\frac{TZ}{TX},\quad \frac{HT}{HV}=\frac{PX}{PY};$$

so that, drawing Xx parallel to YZ to meet HQ and HQ′ in x and x',

$$\frac{HV}{HT}=\frac{PY}{PX}=\frac{PV}{Px},\quad \frac{HV}{VT}=\frac{PV}{Vx}.$$

$$\frac{VP.VT}{HV^2}=\frac{Vx}{HV}=\frac{V'x'}{HV'}=\frac{V'P'.V'T'}{HV'^2} \tag{37}$$

the geometrical equivalent of the relation

$$\left(1-\frac{A}{B}\right)\left(1-\frac{A}{C}\right)=\left(1-\frac{A'}{B'}\right)\left(1-\frac{A'}{C'}\right). \tag{38}$$

Similarly for the other relations, which we have not space to develop.

The A and C employed here require to be carefully distinguished from the values referring to the top itself, which ought to be differentiated by a suffix.

The constancy of the perpendicular from the centre on the tangent plane of the rolling quadric along the polhode is expressed by

$$\frac{x^2}{HV^2}+\frac{y^2}{HT^2}+\frac{z^2}{HP^2}=1, \tag{39}$$

and

$$\frac{x}{HV},\ \frac{y}{HT},\ \frac{z}{HP}$$

are obviously the cosines of the angles which the line HQ makes with the coordinate axes.

The Darboux-Kœnig's arrangements by which the polhode, herpolhode, and associated top motion are produced mechanically by articulated movements, are worth mention and study in elucidating the various theorems.

When the parameters a and b (p. 263) are aliquot parts of the period ω', the multiplicative elliptic functions $\alpha, \beta, \gamma, \delta$ become algebraical functions of u, qualified by exponential functions of the time. Take the simplest case, where $a=\frac{1}{2}\omega'$, $b=\frac{1}{2}\omega'$, equivalent to placing P at A and P′ at B in Fig. 1, then we shall have

$$e=0,\ e'=\kappa,\ e''=\frac{1}{\kappa};$$

$$\alpha=\frac{1}{\sqrt{2}}e^{lti}\left[\sqrt{(e''-u\ .\ e'-u)}+i\frac{1+\kappa}{\sqrt{\kappa}}\sqrt{(u-e)}\right]^{\frac{1}{2}},$$

$$\beta=\frac{1}{\sqrt{2}}e^{l'ti}\left[\sqrt{(e''-u\ .\ e'-u)}-i\frac{1-\kappa}{\sqrt{\kappa}}\sqrt{(u-e)}\right]^{\frac{1}{2}},\ \&c.,$$

with

$$l=\frac{1+\kappa}{4\sqrt{2\kappa}}m+\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N,$$

$$l'=\frac{1-\kappa}{4\sqrt{2\kappa}}m-\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N,$$

$$\tfrac{1}{2}i\sin\theta e^{\psi i}=\alpha\beta=\tfrac{1}{2}e^{(l+l')ti}[\sqrt{(1-\kappa u)}+i\sqrt{(u\ .\ \kappa-u)}].$$

In the next case, where

$$a=\tfrac{2}{3}\omega',\ b=\tfrac{1}{3}\omega',$$

it is found that we can put

$$e=-1+c,\ e'=-\frac{1-3c+c^2}{(1-c)^2},\ e''=\frac{1-c}{c};$$

$$\alpha=\frac{1}{\sqrt{2}}e^{lti}\left[\frac{(1-c+c^2)u+(1-c)^2}{(1-c)\sqrt{c}}+i\sqrt{V}\right]^{\frac{1}{3}}$$

$$\beta=\frac{1}{\sqrt{2}}e^{l'ti}\left[\frac{(1-2c)(2-c)}{(1-c)\sqrt{c}}\sqrt{(e''-u\ .\ u-e)}\right.$$
$$\left.+i\left\{u-2\frac{(1-c)^2}{c}\right\}\sqrt{(e'-u)}\right]^{\frac{1}{3}},\ \&c.$$

with

$$l=\tfrac{1}{3}\frac{1-c+c^2}{(1-c)\sqrt{2c}}\qquad m+\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N$$

$$l'=-\tfrac{1}{3}\frac{(2-c)(1-2c)}{(1-c)\sqrt{2c}}m-\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N.$$

The general form of this solution can now be inferred, but it is evident that the algebraical complexity mounts up very rapidly; with

$$a=\frac{2r\omega'}{n},\ b=\frac{r\omega'}{n},$$

$$\alpha=\frac{1}{\sqrt{2}}e^{lti}\left[A_1+iA_2\sqrt{V}\right]^{\frac{1}{n}},$$

$$\beta=\frac{1}{\sqrt{2}}e^{l'ti}\left[B_1\sqrt{(e''-u\ .\ u-e)}+iB_2\sqrt{(e'-u)}\right]^{\frac{1}{n}},$$

where the A's and B's are rational polynominals of u.

Thus for $n=5$, we can take

$$e=-\frac{2c}{\sqrt{C}+1},\ e'=\frac{c^3-3c^2-c-1}{4c},\ e''=\frac{2c}{\sqrt{C}-1},$$

where

$$C=c^3+c^2-c;$$

and

$$A_1=Pu^2+P_1u+P_2,\ P=\frac{c^3-c^2+7c-3}{2c^{\frac{1}{2}}(c+1)(c-1)^4},$$

$$P_1=\frac{5c^5+11c^4+26c^3-10c^2+c-1}{2c^{\frac{3}{2}}(c+1)^3(c-1)^{\frac{1}{2}}},\quad P_2=\frac{c^4-10c^3+2c^2-2c+1}{c^{\frac{1}{2}}(c+1)^3(c-1)^{\frac{1}{2}}};$$

$$A_2=u+\frac{5c^2-2c+1}{c(c+1)^2},\quad l=\frac{P}{5\sqrt{2}}+\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N;$$

$$B_1=Qu+Q_1,$$

where

$$Q=\frac{(c+3)(c^2-4c-1)}{2c^{\frac{1}{2}}(c+1)(c-1)^{\frac{1}{2}}},\quad l'=\frac{Q}{5\sqrt{2}}-\tfrac{1}{2}\left(\frac{1}{C}-\frac{1}{A}\right)N,$$

$$Q_1=-\frac{(c^2-4c-1)(5c^2+2c+1)}{2c^{\frac{3}{2}}(c+1)(c-1)^{\frac{3}{2}}}.$$

$$B_2=u^2-\frac{5c^3+19c^2+7c+1}{c(c+1)^2(c-1)}u+\frac{-2c^3+22c^2+10c+2}{(c+1)^2(c-1)^2}.$$

The same functions α, β, γ, δ, and their special algebraical forms are suitable for Kirchoff's case of the motion of a solid in infinite liquid, but now V is a quartic function of u, requiring resolution into factors.

In the more general case invented by Clebsch, and developed in Halphen's "Fonctions elliptiques," t. II., the component rotation about OZ is no longer constant, and the solution is more complicated, introducing multiplicative elliptic functions to a parameter corresponding to the infinite value of u.

If the motion of the axis of the top is alone required, we take $\Lambda=\infty$, and investigate the function $\lambda=\alpha/\gamma$; this is a multiplicative elliptic function, with an effective parameter a—b, which can be made algebraical when a—b is made an aliquot part of ω', irrespective of the separate terms a and b. By a further restriction, the exponential function of the time can be made to disappear by making $l+l'=0$, and then H is at L in Fig. 1; it was in this way that the analysis was prepared of the algebraical cases, represented stereoscopically by Mr. T. I. Dewar, referred to on p. 199.

The authors say they have refrained from utilising these stereoscopic diagrams, because they would not like to assume in the reader the possession of a stereoscope. But our eyes should be drilled into control to pick up the solid appearance without any apparatus; a little quiet practice will suffice. Treatises on Solid Geometry of the future should be profusely illustrated with stereoscopic figures, which the student should see solid at will; and wall diagrams or lantern projections should also be drawn stereoscopically, and the solid effect obtained in the audience by crossing the two lines of sight.

Mr. T. I. Dewar's untimely death, at San Remo last May, has deprived us of any further diagrams from his skill, but the example he set will we trust be followed out completely in mathematical diagrammatic instruction.

The unsymmetrical top, discussed in V. § 9, leads into such great analytical complication, that only a few special degenerate cases have so far received any adequate attention; the next century will have its work cut out for the mathematical treatment of this problem and also of the dynamics of the bicycle. The symmetrical top of the boy, with the point free to wander over a smooth or rough horizontal plane, leads to similar analytical difficulties, and should be discussed in the same place.

On the other hand, the many attempts at a popular explanation of the motion of the top, restricted principally to the case of regular precession, are described in V. § 3. Prof. Perry's interesting little book on "Spinning Tops" comes in for praise, and the authors cite with pleasure the comparison of the top to a wilful beast (*eigensinniger thier*), always ready to move in some other direction to that in which it is pushed; insomuch that the Irishman can persuade his pig to accompany him on the road only by pretending that his way lies in the opposite direction; and so Bessemer's invention to steady the motion of a cabin mounted on gimbals, by means of the controlling influence of gyrostats, was a failure.

If the authors are in search of other practical elementary illustrations, they should take the modern centrifugal machine, and examine the practical devices, as in the Weston machine, for controlling the nutations; these devices discovered experimentally without any assistance from theory will serve to elucidate the abstract formulas with advantage.

A third part of this book is still to appear, and we await it with great interest; the work when complete will form an indispensable book of reference for all who wish to make themselves thoroughly acquainted with this complicated problem in Dynamics.

A. G. GREENHILL.

NOTES.

AT Osborne, on Wednesday, August 2, the Queen conferred the honour of knighthood upon Sir William Henry Preece and Sir Michael Foster, Knight Commanders of the Order of the Bath, and invested them with the riband and badge of the Civil Division of the Second Class of the Order, and affixed the star to their left breasts.

THE Hanbury Gold Medal of the Pharmaceutical Society of Great Britain has been awarded to Prof. Albert Ladenburg, of Breslau, for his work on alkaloids and their derivatives.

MR. J. S. BUDGETT, of Trinity College, Cambridge, who accompanied Mr. Graham Kerr on his expedition in search of *Lepidosiren*, has been successful in obtaining eggs and larvæ of the Crossopterygian Ganoid *Polypterus*. From a short account of his investigations, illustrated by sketches, which Mr. Budgett has sent to this country, it appears that the larva is very minute, and possesses a "cement organ" on the dorsal surface of the head. Mr. Budgett is now on the journey home, and the full account of his work will be looked forward to with much interest.

ON a preceding page we have referred to some of the work performed by the Royal Gardens, Kew. Coincidently we have received the number for July 21 of our American contemporary *Science*, which contains an elaborate article by Prof. Underwood, headed "The Royal Botanic Gardens at Kew," in which the features of the garden and its position as a scientific institution—"its beautiful lawns, its delightful shade, its historic associations, its immense collections of cultivated plants, and its wonderful activity in the direction of botanical research"—are described and discussed with critical appreciation *apropos* the recent establishment of the Botanic Garden of New York and its capability to become "even more influential in democratic America than Kew has become throughout the length and breadth of the Queen's dominions." It is gratifying to have this acknowledgment of the work of Kew; and the tribute paid to the versatility and ability of Sir William Thiselton-Dyer in promoting its development and widening its influence will be everywhere endorsed. There are some blots on the escutcheon in the eyes of Prof. Underwood, but we imagine there are many who will not see with him in all the instances he mentions. The crowding of the museum collections he notes is an apparent blemish, and one we may hope to see removed by the provision of increased room for the exhibition of the specimens. A somewhat jealous comparison of Kew and Berlin as centres of botanical work is a jarring note in the article; and Prof. Underwood allows, we fear, German bias to weigh with him in making it, for instance, when he writes, "the principles of plant distribution are not so thoroughly grasped at Kew as they have been brought out at the German Botanical Garden through the skill of Prof. Engler and his associates." Yet Kew is the home of Sir Joseph Hooker!

FOR several years the need of greater facilities for the publication of mathematical investigations has been strongly felt by the members of the American Mathematical Society. This Society has maintained during the past eight years an historical and critical review, known as the *Bulletin* of the American Mathematical Society, and throughout the whole of this period there has been a constantly growing demand for the publication in the pages of that journal of articles not properly falling within its scope. The co-operation of several American colleges and universities was therefore recently invited in a plan whereby such articles may be afforded suitable means of publication. The necessary co-operation has now been secured, and the publication of a quarterly number of the *Transactions* of the American Mathematical Society has been definitely undertaken to begin January 1, 1900. The *Transactions* will be devoted primarily to research in pure and applied mathematics. The editors will welcome all papers containing investigations of sufficient mathematical interest and value. Such papers, in many cases, will be necessarily of considerable length; but the editors will be very glad to receive, also, short contributions which are of such a character as to fall within the scope of the *Transactions*. Papers from mathematicians not belonging to the Society will be welcomed; such papers, if accepted for publication, will be presented to the Society by the editors. Manuscripts intended for publication in the *Transactions* should be addressed either to Prof. E. H. Moore, University of Chicago, Chicago, Ill., or to Prof. E. W. Brown, Haverford College, Haverford, Pa., or to Prof. T. S. Fiske, Columbia University, New York, N.Y.

BY the will of the late Dr. Jules Maringer, the Pasteur Institute at Paris is bequeathed the sum of one hundred thousand francs.

THE death is announced at Olten, Switzerland, of M. N. Rieggenbach, Correspondant of the Paris Academy of Sciences, in the Section of Mechanics.

Science announces the death of Mrs. Elizabeth Thompson, of Stamford, Conn., who made many gifts for benevolent and scientific purposes. She contributed towards the telescope for Vassar College, was one of three "patrons" of the American Association for the Advancement of Science, and endowed the Elizabeth Thompson Science Fund, the income of which is now being so advantageously used for the promotion of scientific research.

A REUTER despatch from St. Petersburg, dated August 2, says:—"News has been received here that the Russian members of the Russo-Swedish Scientific Expedition to Spitsbergen have arrived safely at Horn Sound, where they will winter. Later on they will proceed by land to the western side of the Stor Fiord, where they will engage in geodetic work. Some of the members will not remain over the winter, returning to St. Petersburg in October, but the others will stay in Spitsbergen until the autumn of next year. The Russian members of the expedition have not yet met with their Swedish colleagues; but Prof. Baklund has gone to meet them on board an ice-breaker."

REFERRING to the progress of vaccination, Mr. Chaplin said, in the House of Commons on Thursday last, that the returns which he had obtained showed that the total number of certificates of successful primary vaccination received by the vaccination officers during the first six months of the present year was 353,992 as against 277,821 in the first six months of 1898; that is to say, there has been an increase of upwards of 76,000 primary vaccinations or of more than 27 per cent. in the first six months of the present year as compared with the corresponding period of 1898. These results have been obtained in the first six months of the Act, notwithstanding the difficulty of giving effect to an entire change of method throughout the country from stational to domiciliary vaccination; and also in spite of the fact that in numerous cases there was very considerable delay in the fixing of fees and the appointment of officers.

FROM a note in the *Times* we learn that the section of the famous mpundu tree at Chitambo's, which marked the place where Dr. Livingstone died, has been successfully removed by Mr. Codrington, the Deputy-Administrator of Northern Rhodesia, and will be sent to England for preservation. It will be remembered that two or three years ago Mr. Poulett Weatherley, while exploring in the neighbourhood of Lake Bangweolo, visited Chitambo's and reported that the mpundu tree was in an advanced stage of decay and would probably disappear altogether in a very short time. After careful consideration, the Royal Geographical Society decided that the best course to pursue would be to cut out the section of the tree which bears the inscription and have it sent over to London for preservation at the rooms of the Society. To mark the place where the tree stood, a large cairn has been erected with a staff made of two telegraph poles in the centre, held in place by stays of telegraph wire. This temporary memorial will serve the purpose of preserving the identity of Dr. Livingstone's deathplace until such time as a more permanent memorial is erected.

THE sixth international otological congress was opened on Tuesday at the Examination Hall, Victoria Embankment. Prof. U. Pritchard, the president-elect, was in the chair, and about three hundred aural surgeons from many parts of the world were present. In his presidential address, Prof. Pritchard traced the birth and growth of otological science. Although an ancient Egyptian papyrus had been found on which was written a monograph on deafness and ear diseases, otology, except perhaps with regard to its anatomy and physiology, did not make itself of great importance until the second half of the present century. Between 1840 and 1860 this branch of medical science was vigorously taken up by Sir William Wilde and Toynbee. Since then the means of diagnosis have been considerably improved, while in treatment there has been immense strides, due to the adoption of antiseptic surgery. At the commencement of the present century the ear was regarded almost as a *terra incognita*, scarcely worth consideration except as the seat of one affection only—that which was generally known as "a deafness"—now, at its close, this organ is fully-explored ground, and has been proved well worth the exploration. Otology has been raised from the rank of pseudo-quackery to an honourable position in scientific surgery, and its importance and bearing upon the body as a whole is now fully recognised.

THE results of experiments on the ignition of fire-damp and coal-dust by means of electricity were given in a paper by Herr Heise and Dr. Theim, recently read before the Institution of Mining Engineers. The object of the experiments was to determine to what extent electrically driven machinery is dangerous in fiery or dusty mines. In brief, the sum of the results obtained show that in general the amount of electrical energy which is capable in certain circumstances of igniting fire-damp need only be extremely small. This amount cannot be definitely fixed, however, as it depends not only on the quantity of energy but on the mode of its application and other attendant circumstances. It is only in the case of a current the conditions of which are exactly known that quantitative statements can be made as to the limits of safety for certain classes of transformation of energy. In any case, all visible sparks may be looked upon as dangerous. Experiment alone can decide whether certain classes of sparks

may be devoid of danger. Explosions of coal-dust alone appear to be impossible of production by electricity, unless indeed specially dangerous classes of coal-dust behave differently from those tried.

A COPY of a paper by Dr. J. S. Haldane, F.R.S., and Mr. F. G. Meachem, containing observations on the relation of underground temperature and spontaneous fires in the coal to oxidation and to the causes which favour it, has been received from the Institution of Mining Engineers. The conclusions to which the results of the investigations have led the authors are as follows: (1) A very large amount of heat, sufficient often (if not otherwise absorbed) to heat the air-current to boiling point, is always being formed in a mine, and this heat is almost entirely produced by oxidation of material in the mine. (2) The heat formed greatly exceeds in amount, as a rule, the heat withdrawn by the air-current, so that the temperature of the mine, or of some parts of it, is above that of the strata. (3) The disappearance of oxygen and liberation of heat in the mine are probably due, largely at least, to oxidation of iron pyrites; and the liberation of carbonic acid in the mine is probably due to the action on carbonates of the sulphuric acid thus formed. (4) Coal, when exposed to air, absorbs oxygen, and may also give off carbonic acid and fire-damp, and a very small amount of carbonic oxide. (5) The rate of absorption of oxygen by coal varies directly with the proportion of oxygen present in the air; and as the temperature of the coal increases in arithmetical progression the rate of oxygen-absorption increases in geometrical progression, the ratio of increase (for the coal experimented upon) being about 1/10 for every 4° Fahr. of increase in temperature.

THE engineering papers publish particulars of the series of trials made at Liverpool last week of self-propelled vehicles suitable for heavy traffic. The chief object of the trials was to encourage the development of types of heavy motor wagons suitable for trade and agricultural requirements. The trial runs were made from Liverpool, over distances of from thirty to forty miles, on two successive days. All vehicles were required to traverse the prescribed routes without alternative, and to perform other manœuvres. The distance between any two of the depôts provided for the supply of water did not exceed twelve miles. Steam was used as the motive power in the six vehicles entered for competition this year. Oil was used for fuel in three, coal in two, and coke in one. Electricity and oil motors were unrepresented in the competition. The following awards were made by the judges:—In Class B, for vehicles having a minimum load, 2 tons; maximum tare, 2 tons; minimum level platform area, 50 square feet, a gold medal to the Steam Carriage and Wagon Company (Thorneycroft), Chiswick, and silver medals to Bayley's, Limited, and the Lancashire Steam Motor Company. In Class D, for vehicles with a minimum load of 6½ tons; maximum tare, 4 tons; minimum level platform area, 110 square feet, the gold medal was awarded to the Steam Carriage and Wagon Company (Thorneycroft).

A COMMITTEE of the British Association was appointed in 1896 to take any possible measures to secure uniformity in the pages of scientific transactions and serials, so that parts of various publications can be bound together by those interested in particular subjects. The Committee has already issued one report, and has since been taking steps to bring before the various societies which publish *Proceedings* and *Transactions* the advisability of bringing their publications into harmony, so far as size of paper is concerned, with the standard sizes which already prevail in a great majority of scientific journals and almost uniformly in the case of those longest established. As the result of the inquiries the Committee has issued a circular giving the dimensions of the standard octavo and standard quarto size recommended for scientific publications. It is strongly recommended that every article should always begin at the top of a right-hand page, even if that involves a blank left-hand page, so that a paper can be extracted from a journal without mutilating one or two others.

THE Deutsche Seewarte has published a discussion of the storms experienced in the North Atlantic Ocean during the last week of January and the first weeks of February last. It will be remembered that it was during this exceptionally stormy period that the liners *Pavonia* and *Bulgaria* suffered so severely. The investigation shows that very unusual weather extended from the Rocky Mountains across the whole of the North Atlantic to the Ural Mountains, and that the storms over the British Islands and North-west Europe were accompanied by unusually high temperature, and blizzards occurred over the United States. The principal features of the storms were their great intensity and almost uninterrupted succession, and the period was characterised by the relatively southerly position of the zone in which the principal barometric minima occurred, and pursued the easterly direction in which they usually travel. The work has been prepared by Dr. E. Herrmann, and is illustrated by several charts. We understand that the Meteorological Council are also preparing for publication a more elaborate discussion of this stormy period.

THE Central Physical Observatory and the Geographical Society of St. Petersburg sent up an unmanned balloon on March 24, with duly verified meteorograph. The balloon started about 8 a.m.; in the course of an hour it had attained a height of 10 kilometres and was travelling at the rate of 75 kilometres an hour, according to photogrammetric observations made at Pavlovsk Observatory. The balloon was not found until May 9, 700 kilometres to the east of St. Petersburg. The instruments were in good condition, but the trace had suffered from exposure to the weather. The legible portion showed that at starting the temperature was −3°·8 F.; at 3900 metres it had fallen to −29°·6, at 4925 metres to −41°·3, and at 6559 metres to −60°·1; at 6878 metres the temperature was −62°·9, while at the highest point shown by the curve, 7223 metres, the reading had risen to −61°·4.

A REPORT on clock-rates and barometric pressure as illustrated by the mean-time clock and three chronometers at Mare's Island Observatory, together with a brief account of the observatory, is contributed to the *Publications* of the Astronomical Society of the Pacific, No. 68, by Ensign Everett Hayden, of the U.S. Navy. The paper is illustrated by a diagram of the barometer-rate curve of the mean-time clock, and from this and other tables it is inferred that the best chronometers show a remarkably regular change of rate for differences of pressure, running about '10s. faster for a decrease of '10-inch of mean barometer. It is suggested that the rate curves of such chronometers should be drawn for a mean pressure of 30·00 inches, with similar curves to the right and left for each tenth lower and higher pressures, respectively, for, say, five-tenths of an inch, for the practical use of navigators.

A LENGTHY paper on the influence of magnetism on the luminescence of gases has been contributed to the *Bulletin de la Classe des Sciences* of the Belgian Academy (part 6), by M. A. de Hemptinne. The author has studied the action of magnetism on tubes without electrodes excited by electric vibrations; and he examines in succession the influence of the pressure of the gas, the length of the electric wave, the nature of the gas, and the influence of the medium. The paper concludes with theoretical considerations relating to the observed facts.

PART 6 of the *Bulletin de la Classe des Sciences* of the Belgian Royal Academy contains a preliminary report from the Belgian Antarctic Expedition on the soundings of the *Belgica*, drawn up by M. Henryk Arctowsky. Between the channels of Tierra del Fuego and the archipelago of Dirck Gherrits a section was taken of the large Antarctic channel which separates the extremities of the Andes from the hypothetical Antarctic continent. Moreover, within the Antarctic circle and on the west of Alexander Land a series of soundings were taken while the ship was drifting with the pack ice. The principal bathymetric discoveries were (1) a deep flat-bottomed basin between the south side of the Andes and the mountain system forming the framework of the lands visited by the expedition; (2) in places a sharp declivity forming a demarcation to the continental plateau; (3) the existence of a continental plateau west of Alexander Land, and south of the 71st parallel.

FROM Dr. A. Goldhammer we have received copies of notes published by him in *Wiedemann's Annalen* 65 and 67, dealing, one with modern theories of electromagnetic phenomena in iron, nickel and cobalt, and the other with the Zeeman effect. In the former paper the author compares his equations with those obtained by Mr. J. G. Leathem, of Cambridge.

IN the *Journal de Physique* for June, M. Coloman de Szily investigates the effect of torsion on the electric resistance of wires. The substance used in the experiments was an alloy called "constantan," whose resistance is but slightly affected by changes of temperature. The general conclusions are: that torsion increases the electric resistance of a wire; that up to the limit of elasticity the increase is roughly proportional to the angle of torsion, but beyond that limit it increases more rapidly; and that the resistance of a twisted wire decreases slowly with the time.

IN *Cosmos*, No. 744, M. A. Acloque discusses the affinities between cadelis-flies and moths. The author considers that even if the distance between the Trichoptera and Lepidoptera is not great, there is at the same time a considerable gap separating them, and that little or no light on the question of a previous connection between the two orders is at present afforded by palæontological considerations.

DR. FELICE DELL' ACQUA, writing in the *Rendiconti del R. Istituto Lombardo*, brings forward considerations, both statistical and hygienic, relative to the consumption of meat food. It would appear that in Milan the average daily consumption of meat amounts to only 154½ grammes per head of population, and this the author considers is insufficient. After pointing out the desirability of paying greater attention to the diet, especially of working people, Dr. dell' Acqua discusses the beneficial effects of a fair proportion of meat on the general physique. The various ways of increasing the supply of meat are considered. Dr. dell' Acqua strongly urges the desirability of breeding more cattle in Italy, and of not slaughtering immature animals. Of other sources capable of yielding greater supply than at present, the author calls attention to fish, rabbits and birds, and he suggests the acclimatisation of foreign animals and even the use of horse-flesh. It would appear that in Italy considerably less animals are slaughtered for food in proportion to the population than in France or Germany, or especially England.

UNDER the title "The Honey Bee: a Manual of Instruction in Apiculture," by Mr. Frank Benton, the U.S. Department of Agriculture published a very useful *Bulletin* three or four years ago. Twenty-one thousand copies of the manual have been distributed; and the third edition, containing a few additions and changes, has now been published. The magnitude of the apiarian industry in the United States may be judged from the fact that more than 300,000 persons are engaged in the culture of bees, and the present annual value of apiarian products is estimated at 4,000,000*l*. Mr. Benton states, however, that the present existing flora of the United States could support ten times the number of colonies of bees it now supports. An advantage of this branch of agricultural industry is that it does not impoverish the soil in the least, but, on the contrary, results in better seed and fruit crops. For instance, Dr. L. O. Howard points out that recent investigations have shown that certain varieties of peas are nearly or quite sterile unless bees bring pollen from other distinct varieties for their complete cross fertilisation. Mr. Benton's treatise will continue to be of great assistance to persons engaged in the management of bees for profit.

IN the *Verhandlungen der k. k. geol. Reichsanstalt*, Nos. 6 and 7, 1899, Dr. M. Remeš deals with the question of palæontological divisions in the Tithonian limestone of Stramberg. This limestone, as is well known, has yielded a varied and specially interesting assemblage of life-forms, including types of both jurassic and cretaceous character, and is to be looked upon as representing a true passage series. The author gives a brief account of the attempts that have been made to distinguish divisions of horizon or organic facies in the Stramberg Beds, and points out that insufficient care has hitherto been exercised in keeping separate the fossils collected from the various exposures in the one neighbourhood. With the results of his own studies as a groundwork, as well as the long experience of his father in the same field of observation, Dr. Remeš is enabled to show the character of the fauna collected from five different exposures, and to point out petrographical similarities and differences. He concludes that the Stramberg limestone forms a uniform mass which, while not satisfactorily showing stratification, permits a division according to facies in its different parts. It is found that a separation of the jurassic fauna with *Terebratula moravica* from the cretaceous fauna with *T. janitor*, as proposed by Hébert, cannot be justified; a mingling of jurassic and cretaceous forms occurs in like manner at all the points examined. The division adopted by Dr. Remeš, according to organic facies, is threefold. He distinguishes a cephalopod-facies (in the Kotouč-Schlossberg rock-complex), a coral- and sponge-facies (Gemeindesteinbruch complex), and an echinoderm-facies (in the red limestone of Nesselsdorf). The passage of these single rock-masses into one another is stated to be gradual.

DR. TH. TCHISTOVITCH has made the toxic properties of eel-serum the basis of some important investigations on the mechanism of immunity. These researches emanate from the laboratories of Profs. Metchnikoff and Roux at the Paris Pasteur Institute, and are published in the *Annales*. Amongst other interesting facts brought to light is the discovery that during the process of immunising an animal against the toxic effect of eel-serum, although it may be trained to resist increasing quantities of the toxin, the *antitoxic* properties of this animal's blood-serum do not increase; on the contrary, the antitoxin of a greater or less degree of strength elaborated during the early stages of the immunising process steadily declines in antitoxic value as the animal gains in power of resisting the toxin. The presence, therefore, in the blood of an immunised animal of an antitoxin of a greater or less degree of strength cannot be held to furnish any information or standard as to the degree of immunity acquired by that animal. Immunity, therefore, depends not solely on the production of an antitoxin in the blood, but on some other mechanism which Dr. Tchistovitch considers may in all probability be dependent upon the leucocytes.

AN account of an investigation of a fungus which has done serious damage to the cacao industry in Trinidad is given in the *Kew Bulletin* (Nos. 145-146). Mr. J. H. Hart, Superintendent of the Royal Botanic Gardens, Trinidad, sent to Kew material for examination, and the report upon it states:—"Microscopic examination revealed the presence of two distinct fungous parasites, one being the well-known *Phytophthora omnivora*, De Bary, a species closely allied to *Phytophthora infestans*, De Bary, the cause of the potato disease; the other a *Nectria*, which proves to be new to science, and will be known as *Nectria Bainii*, the name suggested by Mr. Hart in compliment to Mr. Bain, who first called attention to the disease. The *Phytophthora* was present on all the pods sent, and may be considered as the cause of the present epidemic in Trinidad. The same, or a closely allied species, appears to be the cause of the cacao-pod disease in Ceylon. The *Nectria* appeared on two pods, and this again possesses many points in common with the *Nectria*, which has caused such destruction to cacao trees in Ceylon by attacking the bark of the trunk and branches, as described by Mr. J. B. Carruthers. At present no mention is made of other than the pod-disease in Trinidad, but the fact of a parasitic *Nectria* being present necessitates the prompt execution of measures calculated to prevent the parasite from extending its ravages." Mr. G. Massee describes each of the species, and states the measures which should be taken to combat the disease.

REPORTS on experiments on the manuring of oats, hay, and potatoes, and on the feeding of sheep, conducted in 1898 on farms in the centre and south-west of Scotland, are contained in the sixth annual report just issued by the agricultural department of the Glasgow and West of Scotland Technical College. The director of the experiments is Prof. R. Patrick Wright, and under his guidance a large amount of serviceable information, similar in character to that obtained at the Agricultural Experiment Stations in the United States, Canada, and elsewhere, has been made known. By a scheme framed by the Scotch Education Department, the Agricultural Department of the College referred to has been merged into the newly-formed West of Scotland Agricultural College; so the present report is the last of its series, though it is hoped that under the new college a considerable development of the scope and usefulness of the work of agricultural education and research will be rendered possible.

VOL. I. No. 12, of the Records of the Botanical Survey of India is occupied by Mr. V. F. Brotherus' Contributions to the Bryological Flora of Southern India. A number of new species of moss are described.

THE first part of the second volume of the British Museum Catalogue of the African Plants collected by Dr. Friedrich Welwitsch, dealing chiefly with the monocotyledons of the collection, by Dr. A. B. Rendle, has been published.

MESSRS. SWAN SONNENSCHEIN AND CO. have published a second impression of "An Introduction to the Study of Zoology" by Mr. B. Lindsay. The volume is intended for readers beginning the study of zoology, and its chief distinctive characteristic is said to rest "in its attempt to present the system of classification by grades in a form suited to the necessities of elementary and popular teaching."

THE number of the *Biologisches Centralblatt* for July 15 contains a very useful summary, by Prof. Moebius, of recent advances in our knowledge of the mode of impregnation in Gymnosperms and other flowering plants, derived from the remarkable observations of Webber, Ikeno, Hirasi, Nawaschin, Guignard, and Lotsy. The paper is illustrated by several figures.

To the practical engineer Molesworth's "Pocket-book of Useful Formulæ and Memoranda" is invaluable. The fact that the twenty-fourth edition, revised and enlarged, has just been published, indicates the extent to which the book has met with approbation. An entirely new electrical section has been added, and will increase the usefulness of what has long been a very serviceable manual.

Contributions from the Botanical Laboratory of the University of Philadelphia, Vol. ii. No. 1, is full of interesting papers. Dr. Lucy L. W. Wilson has some observations on the life-history of *Conopholis americana*, a remarkable American parasitic plant belonging to the Orobancheæ. Elizabeth A. Simons gives the results of a series of experiments on the rate of circumnutation of the growing stem of some flowering plants, which she finds to be considerably more rapid than the rate stated by Darwin. Mr. R. E. B. McKenney describes observations on the development of some embryo-sacs, chiefly *Scilla* and *Hyacinthus*. The present publication affords one among many illustrations of the extent to which scientific research is being carried out by ladies in the United States. Out of nine papers in this number, five are by women.

THE first number of the *Yorkshire Ramblers' Club Journal* is a very creditable production. Original contributions, reviews, illustrations, and reprints of articles which have appeared elsewhere are included, dealing with various phases of activity of the Club. Noteworthy among the subjects dealt with are the mountains and snow fields of Norway, and the caves and pot-holes of Yorkshire. A large number of the caves in the carboniferous limestone still remain unexplored; and the Club is busily engaged in this almost inexhaustible field of "underground mountaineering" and research. The manner in which the work of exploration has been carried on and the results achieved have already conferred distinction upon the Club, no less than on the members who are its pioneers. We shall look to future numbers of the *Journal* for particulars of new explorations.

SEVERAL publications containing the results of meteorological observations have lately come to hand. From Prof. J. M. Pernter we have received vols. 32, 33-35 of the Jahrbücher of the K.K. Central-Anstalt für Meteorologie und Erdmagnetismus, Vienna, containing tabulated results of daily meteorological observations made in Austria during 1895, 1896 and 1898.—The Jahrbuch of meteorological observations made during 1897 at the observatory attached to the *Magdeburgische Zeitung*, edited by Herr R. Weidenhagen, has, in addition to the usual tables, a number of curves showing graphically some of the results.—The Ergebnisse of hourly observations made at Bremen in 1898, edited by Prof. Paul Bergholz, have been published.—Sir Cuthbert E. Peek has issued his annual statement of meteorological observations made at his observatory, Lyme Regis, during 1898. A special tower has been erected for the anemometers, and upon it are placed a Dines' pressure-tube recording anemometer and a Robinson anemometer, so that the two instruments can now be compared under very favourable conditions.

SEVERAL new editions of scientific works have lately been received. The publication, by Mr. Murray, of the third edition of Mr. Edward Whymper's guide to "The Valley of Zermatt and the Matterhorn" and the fourth edition of "Chamonix and the Range of Mont Blanc" is well-timed. All visitors to Switzerland should provide themselves with one or both of these interesting and serviceable handbooks.—A second edition of Prof. Henry Louis's "Handbook of Gold Milling" has been published by Messrs. Macmillan and Co. The book originally appeared in 1893, since which date great advances have been

made in the art of gold extraction. So far as possible, account has been taken of all important processes in bringing the book up to date.—Dr. David Walsh's volume on "The Röntgen Rays in Medical Work" (Baillière, Tindall, and Cox) contains much information of interest to all who desire to know how far Röntgen rays have been utilised in medical and surgical cases. To the physician and surgeon this second edition should be of great service in showing what has been done. Referring to the progress made since the publication of the first edition, Dr. Walsh says: "In practical work the times of exposure are shorter, results more certain, and the merits of the statical machine more widely recognised."—A second edition of "A Text-book of Applied Mechanics," by Prof. Andrew Jamieson, has been published by Messrs. Charles Griffin and Co., Ltd. This book has been revised and extended, the chief additions being in the part on hydraulics and hydraulic machines.—The case for cremation as a means of disposing of the dead is forcibly stated by Sir H. Thompson in "Modern Cremation" (Smith, Elder, and Co.), the third edition of which, revised and much enlarged, has just been published. The volume brings up to the present date the history of the practice of cremation, and of the work of the Cremation Society of England.

THE additions to the Zoological Society's Gardens during the past week include a Tantalus Monkey (*Cercopithecus tantalus*) from West Africa, presented by Mr. W. Knight; two Hairy Armadillos (*Dasypus villosus*), a Geoffroy's Cat (*Felis geoffroii*) from La Plata, presented by Mr. W. Brown; a Magpie (*Pica rustica*), British, presented by Mr. S. B. Goldsmith; a Red-eared Bulbul (*Pycnonotus jocosus*), a Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Miss Petrocochino; two Goshawks (*Astur palumbarius*), European, presented by M. P. A. Pichot; three Spotted Tinamous (*Northura maculosa*) from Buenos Ayres, four Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, presented by Mr. Ernest Gibson; two Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, two Maholi Galagos (*Galago maholi*) from South Africa, a Sooty Phalanger (*Trichosaurus fuliginosus*) from Tasmania, a Malabar Squirrel (*Sciurus maximus*, var. *dealbatus*) from India, a Long-necked Chelodine (*Chelodina longicollis*) from South Australia, two Serrated Terrapins (*Chrysemys scripta*) from North America, deposited; a Grison (*Galictis vittata*) from South America, two Superb Tanagers (*Calliste fastuosa*), a Blue and Black Tanager (*Tanagrella cyanomelaena*) from Brazil, a Thick-billed Tanager (*Euphonia laniirostris*) from Central America, purchased; a Common Mynah (*Acridotheres tristis*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

HOLMES' COMET, 1899 *d* (1892 III.).—A new ephemeris for this comet is given by Mr. H. J. Zwiers in *Astr. Nach.* (Bd. 150, No. 3582). It is important that as many observations as possible should be secured, in order to provide the necessary data for a more correct determination of the orbit.

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″	r^{-2}.	Br. $(r\Delta)^{-2}$.
Aug. 10 ...	2 43 48·80 ..	34 39 46·4		
11 ...	44 56·27 ...	34 55 39·6		
12 ...	46 2·64 ...	35 11 29·8 ...	0·1940 ...	0·04674
13 ...	47 7·89 ..	35 27 16·9		
14 ...	48 11·99 ...	35 43 0·9		
15 ...	49 14·92 ...	35 58 41·7		
16 ...	50 16·66 ...	36 14 19·2 ...	0·1923 ...	0·04781
17 ...	2 51 17·17 ...	36 29 53·4		

COMET SWIFT (1899 *a*).—Observers still interested in this comet, and possessed of the necessary optical means, will find an extended ephemeris in the *Astr. Nach.* (Bd. 150, No. 3583) by Herr J. Möller, of Kiel. The positions and relative brightness are given up to September 16, but it is only with the largest instruments that the comet can be at all detected.

THE NEW ALGOL VARIABLE.—In *Harvard College Observatory Circular*, No. 44, Prof. E. C. Pickering gives an ephemeris for observations of this recently discovered variable. The following are the predicted minima during the nights of the present month:—

Heliocentric Minima of B.D. 45°·3062.

1899, August 11, at 11h. 43m.
,, ,, 20, at 15h. 12m.

The position of the star is

R.A. ... 20h. 2·4m.
Decl. ... + 45° 53′ } (1855),

and its normal magnitude about 8·6.

DOUBLE STAR CATALOGUE.—Mr. R. G. Aitken has communicated to the *Astr. Nach.* (Bd. 150, Nos. 3584-5) his observations of 319 double stars made during the year 1898. The measures were made with the filar micrometer, in conjunction with either the 12-inch or 36-inch refractor, at the Lick Observatory. The star places are all reduced to epoch 1900, and the data given are time of observation, position angle, distance of components, and their individual magnitudes.

ELEMENTS OF COMETARY ORBITS.—M. G. Fayet has extended Oppolzer's "Traités des Orbites," and brought it up to date by giving the approximate elements for the year 1900 of all the comets hitherto observed. The list is divided into three portions, dealing with comets having elliptic, parabolic, and uncertain orbits respectively; 106 comets are given with elliptic elements, and 104 with parabolic elements, the dates of observation extending from 1702 to the present time. Fifty-one comets of uncertain elements are given, extending from 137 B.C. to 1880. This list of cometary elements will be especially useful in referring to the elements of any new comet, to see if it is really a new member of the solar system or a return of one previously recorded.

THE FUR-SEAL HERDS OF THE NORTH PACIFIC.

FEW commercial industries command a more varied or more widely spread series of interests than does the sealing trade of the North Pacific. In addition to the great biological interest attaching to the seal-herds, we have, first of all, a considerable number of Aleuts dwelling on the islands to drive, kill, and skin the seals, and who subsist to a certain extent on seal-flesh. Then there is the revenue drawn by the American and Russian Governments for the right of sealing on their respective islands, as well as the Customs dues levied by the former on the dressed seal-skins when re-imported into their territory. Not to mention the transport of the raw hides, the dressing of the latter and their conversion into commercial seal-skin forms a very important industry in London, which employs a large number of hands. There are, moreover, the vessels and their crews, which have of late years been engaged in pelagic sealing; a large proportion of which sailed from Canadian ports. Finally, there is the manufacture of the finished seal-skin into garments, and the retail sale of the latter.

From all points of view a cordial welcome should, therefore, be extended to the issue by the United States Government of the official Report of the Commissioner in charge of the fur-seal investigations of 1896-97. This Report, which bears the title of "The Fur-Seals and Fur-Seal Islands of the North Pacific Ocean," is in two parts, and comprises the final results of the investigations carried on by the Commissioner and his associates, as well as the recommendations jointly formulated by the American and British members of the International Commission.

The fur-seals of the Northern Pacific comprise three distinct herds, which are stated to keep strictly apart from one another, having each their own breeding-places, feeding-grounds, and routes of migration. The most important of the three herds is the one resorting for breeding purposes in summer to the islands of St. Paul and St. George in the Pribyloff group, situated on the eastern side of Bering Sea. In winter this herd

passes through the channels of the Aleutian chain into the Pacific, ranging as far south as Southern California, and returning to their summer haunts along the American coast. Next in importance is the Komandorski herd, the members of which breed upon Bering and Medui islands in that group, migrating in winter down the eastern coast of Japan, and returning by the same route the following summer. Smallest of all is the Robben Island herd, now restricted to Robben, or Tiuleni Island, in the Sea of Okhotsk, just south of Saghalien, but which formerly also colonised four islands of the Kurile chain. The line of migration of this herd lies through the Sea of Japan, so that it never enters the open Pacific. Whereas the Pribyloff herd, which is the one to which the present Report, so far as published,[1] mainly refers, is the property of the Government of the United States, the other two belong to Russia. So far as can be ascertained, the Komandorski and Pribyloff herds were unknown to man (except during migration) till the discovery of the former islands by Bering in 1741, and of the latter by Pribyloff in 1786.

Hitherto the seals of all three herds have been regarded as constituting a single species, *Otaria* (or *Callorhinus*) *ursina*, although differences in colour, shape, and the character of the fur have long been known to exist between them. From the complete isolation of the three herds, and the apparent absence of intermediate forms, Dr. Jordan, the American Commissioner, feels justified in regarding them as indicating as many distinct species, the leading characteristics of which are indicated in the Report. The typical *ursina* is represented by the Komandorski herd, while to the Pribyloff form is assigned the name *alascana* (*alascanus* if *Callorhinus* be recognised as a genus) and to the Robben Island seals that of *curilensis*. To our own thinking it would have been better if these three forms had been regarded as subspecies, and that such a classification at one time occurred to Dr. Jordan, seems to be indicated by the circumstance that the page (45) of the Report on which they are described is headed "The Subspecies of Fur-Seal."

The fact that the fur-seals resort every summer in great numbers to the Pribyloffs for breeding purposes is doubtless well known to the great majority of our readers, but as some new facts in regard to their period of residence on the islands and their habits while there are recorded in the Report, a brief sketch of this period of their existence may not be out of place.

The old breeding "bulls" are the first to put in an appearance, their average date of landing being about the first of May. The younger bulls do not land till the arrival of the "cows," when they "haul out" and pass round the "rookeries" to places in the rear, or fight their way through the territories of the old bulls in possession. The "bachelors," or immature males, begin to arrive about the same time as the old bulls, usually making their appearance according to age; the smaller seals beginning to predominate after July 9. The older bachelors being alone killed in the Pribyloffs, as many as possible are slaughtered before the arrival of their younger brethren, regular driving usually commencing about June 1. It is about June 10 that the adult cows begin to arrive, their appearance and landing, like that of the adult bulls, being gradual. Their arrival is not, as has been stated to be the case, an occasion of fighting among the old bulls for their possession. As a rule, a female about to land reconnoitres the shore by swimming backwards and forwards, and then lands on the rocks, where she is immediately taken in charge by the nearest bull. If a bull discovers her while attempting to land, she endeavours to escape; but if this is impracticable, she submits and takes her station on shore beside him. When a bull once obtains a cow, his station becomes an objective point for all the others landing in the vicinity, and a "harem" is thus formed; large "harems" being thus constituted in the neighbourhood of favourite landing-places. Soon after landing the cows give birth to their "pups" (one in number to each cow).

In the larger rookeries as many as a hundred cows may go to the formation of a single harem; and so long as they remain quietly resting before and after the birth of their pups, the one bull has no difficulty in keeping them under control. But as soon as the pairing-season sets in (which it does very soon after the birth of the pups) the old bull is unable to manage his harem, and the "idle bulls" around enter the circle. With the "podding" (collection in masses) and scattering of the pups and the influx of fresh cows, the area occupied by the seals gradually extends, and fresh bulls are taken into the circle, until the utmost limits of expansion are reached.

The population of breeding cows gradually increases from the beginning of the season till about the middle of July, from which period it diminishes till the close of the breeding-season, about August 1, the height of the season being about July 15, when the maximum number of breeding cows are on shore. It is not, however, to be assumed that by any means all the cows are then on land—quite the contrary. From about June 10 or 12 onwards fresh cows are constantly arriving at the rookeries, each cow making a sojourn of about ten or twelve days, after which she starts on her first excursion to the feeding-grounds, distant between one and two hundred miles. The height of the season accordingly means merely that the stream of arriving cows is about counterbalanced by the departing one.

Throughout the breeding-season a band of sleeping, playing, and swimming seals skirts the sea-front of each rookery, the majority of these being cows, although some are bachelors. This band includes the arriving and departing cows; the former gradually edging themselves nearer and nearer to the shore, while the latter tend to the seaward fringe. So stealthily is the landing and the departure accomplished, that it is a very difficult matter to observe a cow either in the act of landing or of setting out to sea. One reason of the loitering before landing seems to be to allow time for the complete digestion of the food, which always takes place while at sea. As the bachelors likewise make periodical journeys to the feeding-grounds, it is evident that it is only the bulls which fast throughout the breeding-season; and for the purpose of enduring this, they accumulate a thick layer of blubber previous to landing.

On landing from one of her feeding expeditions the cow calls lustily for her pup, on finding which she forthwith proceeds to nurse it, the pup then departing and taking no further notice of its parent till it again requires a meal. As the majority of the cows are at sea, a landing cow is immediately surrounded by hungry, and it may be starving, pups, who are driven away with decidedly savage treatment. The pups are entirely dependent upon their own mother's milk till about November, the Commission scouting the idea that there is any promiscuous feeding of the pups by the cows, or that the former subsist in part on a vegetable diet.

Mention remains to be made of the landing of the yearling and two-year-old females, whose brothers come to the islands about the first of July and spend their time on the hauling grounds. The two-year-old females reach the rookeries about August 1, and take up their places either in the old harems, or in fresh ones in front of and behind the regular breeding-grounds. Here they are taken charge of by young bulls, and after a short sojourn return to the water. Although the yearling cows apparently arrive with the two-year-olds, they do not make their appearance on the rookeries much before September, and then spend their time in ranging over the latter and playing with the pups, which by this time have become strong swimmers.

In regard to the breaking up of the breeding-season, the old harem-bulls, who have fasted from the beginning of May, begin to desert the rookeries for the feeding-grounds about July 25, their places being taken by the idle bulls. By some time between August 5 and 10, all the adult bulls have departed; the breeding-grounds being then occupied by the younger bulls and bachelors, who, however, soon return to the sand beaches. At the first approach of winter, which usually occurs in November, the cows and pups start on their journey southward. The bachelors linger for some time longer, in some years a considerable number remaining till the end of December or even well on in January; while in mild seasons some may be seen all through the winter. As a rule, however, November ends the sojourn of the seals on the Pribyloffs, and, class by class, they set out on their winter migration.

Such is, very briefly, the life-history of the fur-seals during their sojourn around and on the Pribyloffs. We now proceed to notice, with equal brevity, the decline which has of recent years taken place in the numbers of the herd, the reasons for such decline, and the remedies suggested for its recovery. Since these islands came under the sway of the United States Government only bachelors of a certain age have been allowed to be killed on shore. From 1869 to 1889 the sealing rights were leased to the Alaska Commercial Company, whose annual quota of skins was limited to 100,000, of which 75,000 were to be taken on St. Paul and the remainder on St. George. On

[1] Two other parts of the Report are announced, the second (iv.) of which will deal with the Komandorski and Robben Island herds.

the expiration of this lease the islands were relet for a period of twelve years to the North American Commercial Company, on more advantageous terms, the quota of skins being fixed for the first year at 60,000, while it has since been under the regulation of the Secretary to the Treasury.

Putting aside for subsequent mention the question of pelagic sealing, it may be observed that between the years 1871 and 1875 the number of breeding seals and young on the islands was estimated by Mr. Elliott, in round numbers, at 3,193,000. In spite, however, of the fact that this observer did not recognise that only a portion of the cows were on land at any one time, the Commission concludes that this estimate is far too high, and that 1,400,000 would have been a much closer approximation to the truth. They further state that between 600,000 and 700,000 seems to be a fair estimate of the number of breeding females resorting annually to the islands between the years 1871 and 1885; while at the present time (1896-97) the number is only about one-fifth of what it then was.

As regards the decline of the Pribyloff herd, the best evidence is afforded by the fact that whereas between the years 1871 and 1885 no difficulty was experienced in obtaining the full number of 100,000 bachelor seals of the proper age before July 20, in 1896 it was only found possible to obtain 30,000 fit for killing even by continuing the drives till July 27; while in the following year, when driving was carried on as late as August 11, only 20,890 were obtained. It is largely on these data that the above-mentioned estimate of the former number of breeding animals is founded.

The life of the female seal being estimated at from ten to fifteen years, thirteen years may be taken as an average, during ten of which she is capable of producing young. On this estimate 10 per cent. of the breeding females die of old age each winter, in addition to those which perish from other causes. The stock is replenished by the annual addition of the three-year-old females. Among the young and pups the death-rate from natural causes is very high; about two-thirds thus perishing annually before they attain the age of three years, when the females are fit for breeding and the males for killing. The most important of such natural causes are the presence of a parasitic worm on the sandy breeding-grounds, the trampling to death by the ordinary movements or fights of the adults, starvation of the pups from being separated from their mothers at a very early age, destruction by the killer-whale, and drowning during the winter storms.

In 1896 the number of females with pups on the islands was about 157,000, and in the following year 130,000. In certain rookeries the number of pups had diminished from about 16,240 in 1896 to about 14,320 in 1897, indicating a decrease of about 12 per cent., the number of harems having likewise diminished by about 10½ per cent. Although precise figures are not available, the total decrease in the number of breeding females for the same period may be put down at about 15 per cent., and that of the males fit for killing at about 30 per cent.

Although the exact number to which it is safe to reduce the breeding bulls in a rookery as compared to the cows has not yet been ascertained, it is quite certain that in the Pribyloff herd there is no reduction of the former to anything near that limit. Consequently the killing carried on in the islands cannot be held responsible for the serious reduction which has of late years taken place in the numbers of the herd. On the contrary, such thinning out of the bachelors has tended to the actual increase of the breeding herd, owing to the less amount of fighting which takes place when the bulls are reduced in number, and the consequent diminished loss of life among the cows and pups owing to such fights.

On the other hand, there is every reason for believing that the waning of the herd is solely to be attributed to pelagic sealing, in which the number of females taken is very largely in excess of the males, while for each female so killed an unborn pup is also destroyed, and in the case of those which have already bred a second pup is starved miserably to death on land. Since the normal rate of increase of the breeding herd is a little short of 17 per cent., while the natural death-rate from old age is not far from 10 per cent., it follows (without allowing for other natural causes of death among the adults) that not more than about 6-2/3 per cent. of the females can be destroyed by human agency year by year without involving the ultimate destruction of the herd. This limit has been very largely exceeded as the result of pelagic sealing, in which (in spite of statements to the contrary) it is impossible to distinguish females from males until too late; and in consequence of this the Pribyloff herd has been so reduced that neither pelagic nor land sealing yields an adequate profit on the money invested. The Commission, indeed, go so far as to say that from a commercial point of view the herd is virtually destroyed. "But this," they add, "has not involved the biological destruction of the herd. Under wise protection it may regain its former numbers." That such protection (which involves the prohibition of the killing of females, and therefore apparently also of pelagic sealing[1]) may be extended to the herd while there is yet time, must be the hope of every naturalist. R. L.

INHERITANCE OF LONGEVITY IN MAN.

THE object of this paper[2] is twofold, namely:—

(1) To ascertain whether duration of life is inherited, and

(2) To exhibit natural selection at work in man.

According to both Wallace and Weismann the duration of life in any organism is determined by natural selection. An organism lives so long as it is advantageous, not to itself, but to its species that it should live. But it would be impossible for natural selection to determine the fit duration of life, as it would be impossible for it to fix any other character, unless that character were inherited. Accordingly a preliminary inquiry as to whether duration of life is inherited or not seems needful before we consider further the plausibility of Wallace and Weismann's hypothesis. The present paper shows that directly and collaterally duration of life is certainly inherited in the male line. We believe this to be the first quantitative measure of the inheritance of life's duration. Further data for the inheritance of this character in the female line, and for the study of the inheritance of "brachybioty" or shortlivedness as distinguished from longevity are now being collected. We point out in the paper and endeavour to illustrate by examples the importance of such quantitative measure of the inheritance of life's duration for actuarial practice.

The second aim of our paper seems to us, perhaps, to have the greater scientific importance. In the presidential address at the Oxford meeting of the British Association we were told that no one had seen natural selection at work. In a criticism then published by one of us, it was suggested that every one who had examined a mortality table had seen natural selection at work. Now the meaning of natural selection is absolutely simple. All individuals die, but some, better suited by their constitution and characters to their environment than others, survive longer, and so are able, or better able, to reproduce themselves, and to protect for a longer period their offspring. To assert that natural selection does not exist, is to assert that the whole death-rate is non-selective, or is not a function of the constitution and characters of the individual. Looked at from this standpoint the existence of natural selection really becomes a truism. All that remains when we desire to see it at work is to determine the relative amounts of the selective and non-selective parts of the death-rate for individuals living under the like environment. If, therefore, individuals living under much the same conditions are dealt with, the determination of the selective and non-selective death-rates is a measure of the quantitative amount of natural selection. Now we can answer this problem in two ways. First we may take any organ, and determine whether the death-rate is a function of the size of this organ. This method, adopted by Prof. Weldon, would be the direct and best method, if the results were not apt to be screened by other factors. In the first place we have to hit upon some organ upon which vitality largely and sensibly depends; and this is not easy, for constitutional power of resisting the attacks of disease may depend upon, not one organ, but on the complex relationships of a system of organs, and in the next place the whole problem is rendered difficult by changes due to growth. In the second method we do not attempt to select any organ whatever, but select individuals having any general

[1] The writer takes this opportunity of mentioning that, misled by a summary of some of the evidence given before the Paris Commission, he was inclined in the "Royal Natural History" to pronounce pelagic sealing more humane than seal-killing on land.

[2] "Data for the Problem of Evolution in Man. II. A First Study of the Inheritance of Longevity and the Selective Death-rate in Man." By Miss Mary Beeton and Karl Pearson, F.R.S., University College, London. Received May 29. (Abstract of a paper read before the Royal Society, June 15.)

resemblance in their constitution, or in the whole complex of organs and characters, and correlate their fitness for surviving. Now relations or members of the same family are precisely such individuals. If there were no selective death-rate there would be no correlation between the ages of death of, say, brothers. If there were no non-selective death-rate, we ought to find that the correlation between ages of death of brothers takes the value determined for the coefficient of heredity in brothers, *e.g.* the ·4 of stature, fore-arm, cephalic index, eye colour, &c., Actually we find it to be something sensibly less than ·4. Our investigation shows that, in round numbers, about 80 per cent. of the death-rate is selective in the case of mankind. To that extent natural selection is actually at work. Combined with the quantitative measures of heredity already published, or obtained if not yet published, we can safely conclude that Darwin's theory of a progressive change due to natural selection combined with heredity applies even to mankind to an extent which can be quantitatively measured. The next stage must be an experimental one. Various types of life ought to be submitted to ordeals of a kind like to those which occur in nature, and the correlation between the powers of resistance to these ordeals existing in members of the same family or brood determined. We shall thus be able to ascertain under a variety of circumstances the relative proportions of the selective and non-selective death-rates. A careful inspection of the characters of the longer-lived families may possibly enable the trained biologist to select some organs or characters to which a direct application of Prof. Weldon's method can be made, and thus enable us to distribute, so to speak, the total selective death-rate previously discovered among its chief factors; but here it must be remembered that relationship of organs may be quite as important as absolute size. The present paper is merely a preliminary study of the selective death-rate in man; but one may venture to express a hope that in a comparatively few years, if enough workers can be found for the experimental side of the subject, we shall no longer hear natural selection spoken of as hypothetical, but rather its quantitative measure given for various organisms under divers environments.

THE CAUSE AND PREVENTION OF MALARIA.[1]

I HAVE the honour to address you, on completion of my term of special duty for the investigation of malaria, on the subject of the practical results as regards the prevention of the disease which may be expected to arise from my researches; and I trust that this letter may be submitted to Government if the Director General thinks fit.

It has been shown in my reports to you that the parasites of malaria pass a stage of their existence in certain species of mosquitoes, by the bites of which they are inoculated into the blood of healthy men and birds. These observations have solved the problem—previously thought insolvable—of the mode of life of these parasites in external nature.

My results have been accepted by Dr. Laveran, the discoverer of the parasites of malaria; by Dr. Manson, who elaborated the mosquito theory of malaria; by Dr. Nuttall, of the Hygienic Institute of Berlin, who has made a special study of the relations between insects and disease; and, I understand, by M. Metchnikoff, Director of the Laboratory of the Pasteur Institute in Paris. Lately, moreover, Dr. C. W. Daniels, of the Malaria Commission, who has been sent to study with me in Calcutta, has confirmed my observations in a special report to the Royal Society; while, lastly, Prof. Grassi and Drs. Bignami and Bastianelli, of Rome, have been able, after receiving specimens and copies of my reports from me, to repeat my experiments in detail, and to follow two of the parasites of human malaria through all their stages in a species of mosquito called the *Anopheles claviger*.

It may, therefore, be finally accepted as a fact that malaria is communicated by the bites of some species of mosquito; and, to judge from the general laws governing the development of parasitic animals, such as the parasites of malaria, this is very probably the only way in which infection is acquired, in which opinion several distinguished men of science concur with me.

In considering this statement it is necessary to remember that it does not refer to the mere recurrences of fever to which people previously infected are often subject as the result of chill, fatigue, and so on. When I say that malaria is communicated by the bites of mosquitoes, I allude only to the original infection.

It is also necessary to guard against assertions to the effect that malaria is prevalent where mosquitoes and gnats do not exist. In my experience, when the facts come to be inquired into, such assertions are found to be untrue. Scientific research has now yielded so absolute a proof of the mosquito theory of malaria that hearsay evidence opposed to it can no longer carry any weight.

Hence it follows that, in order to eliminate malaria wholly or partly from a given locality, it is necessary only to exterminate the various species of insect which carry the infection. This will certainly remove the malaria to a large extent, and will almost certainly remove it altogether. It remains only to consider whether such a measure is practicable.

Theoretically the extermination of mosquitoes is a very simple matter. These insects are always hatched from aquatic larvæ or grubs which can live only in small stagnant collections of water, such as pots and tubs of water, garden cisterns, wells, ditches and drains, small ponds, half-dried watercourses, and temporary pools of rain-water. So far as I have yet observed the larvæ are seldom to be found in larger bodies of water, such as tanks, rice-fields, streams and rivers and lakes, because in such places they are devoured by minnows and other small fish. Nor have I ever seen any evidence in favour of the popular view that they breed in damp grass, dead leaves, and so on.

Hence, in order to get rid of these insects from a locality, it will suffice to empty out or drain away, or treat with certain chemicals, the small collections of water in which their larvæ must pass their existence.

But the practicability of this will depend on circumstances—especially, I think, on the species of mosquito with which we wish to deal. In my experience, different species select different habitations for their larvæ. Thus the common "brindled mosquitoes" breed almost entirely in pots and tubs of water; the common "grey mosquitoes" only in cisterns, ditches and drains; while the rarer "spotted-winged mosquitoes" seem to choose only shallow rain-water puddles and ponds too large to dry up under a week or more, and too small or too foul and stagnant for minnows.

Hence the larvæ of the first two varieties are found in large numbers round almost all human dwellings in India; and, because their breeding grounds—namely, vessels of water, drains and wells—are so numerous and are so frequently contained in private tenements, it will be almost impossible to exterminate them on a large scale.

On the other hand, spotted-winged mosquitoes are generally much more rare than the other two varieties. They do not appear to breed in wells, cisterns and vessels of water, and therefore have no special connection with human habitations. In fact it is usually a matter of some difficulty to obtain their larvæ. Small pools of any permanence—such as they require—are not common in most parts of India, except during the rains, and then pools of this kind are generally full of minnows which make short work of any mosquito larvæ they may find. In other words, the breeding grounds of the spotted-winged varieties seem to be so isolated and small that I think it may be possible to exterminate this species under certain circumstances.

The importance of these observations will be apparent when I add that hitherto the parasites of human malaria have been found only in spotted-winged mosquitoes—namely, in two species of them in India and in one species in Italy. As a result of very numerous experiments I think that the common brindled and grey mosquitoes are quite innocuous as regards human malaria—a fortunate circumstance for the human race in the tropics. And Prof. Grassi seems to have come to the same conclusion as the result of his inquiries in Italy.

But I wish to be understood as writing with all due caution on these points. Up to the present our knowledge, both as regards the habits of the various species of mosquito and as regards the capacity of each for carrying malaria, is not complete. All I can now say is that if my anticipations be realised—if it be found that the malaria-bearing species of mosquito multiply only in small isolated collections of water which can easily be dissipated—we shall possess a simple mode of eliminating malaria from certain localities.

I limit this statement to certain localities only, because it is obvious that where the breeding pools are very numerous,

[1] Report from Major Ronald Ross to the Secretary to the Director General, Indian Medical Service, Simla. Dated Calcutta, February 16.

as in water-logged country, or where the inhabitants are not sufficiently advanced to take the necessary precautions, we can scarcely expect the recent observations to be of much use—at least for some years to come. And this limitation must, I fear, exclude most of the rural areas in India.

Where, however, the breeding pools are not very numerous, and where there is anything approaching a competent sanitary establishment, we may, I think, hope to reap the benefit of these discoveries. And this should apply to the most crowded areas, such as those of cities, towns and cantonments, and also to tea, coffee, and indigo estates, and perhaps to military camps.

For instance, malaria causes an enormous amount of sickness among the poor in most Indian cities. Here the common species of mosquitoes breed in the precincts of almost all the houses, and can therefore scarcely be exterminated; but pools suitable for the spotted-winged varieties are comparatively scarce, being found only on vacant areas, ill-kept gardens, or beside roads in very exceptional positions where they can neither dry up quickly nor contain fish. Thus a single small puddle may supply the dangerous mosquitoes to several square miles containing a crowded population: if this be detected and drained off—which will generally cost only a very few rupees—we may expect malaria to vanish from that particular area.

The same considerations will apply to military cantonments and estates under cultivation. In many such malaria causes the bulk of the sickness, and may often, I think, originate from two or three small puddles of a few square yards in size. Thus in a malarious part of the cantonment of Secunderabad, I found the larvæ of spotted-winged mosquitoes only after a long search in a single little pool which could be filled up with a few cart-loads of town rubbish.

In making these suggestions I do not wish to excite hopes which may ultimately prove to have been unfounded. We do not yet know all the dangerous species of mosquito, nor do we even possess an exhaustive knowledge of the haunts and habits of any one variety. I wish merely to indicate what, so far as I can see at present, may become a very simple means of eradicating malaria.

One thing may be said for certain. Where previously we have been unable to point out the exact origin of the malaria in a locality, and have thought that it rises from the soil generally, we may now hope for much more precise knowledge regarding its source; and it will be contrary to experience if human ingenuity does not finally succeed in turning such information to practical account.

More than this, if the distinguishing characteristics of the malaria-bearing mosquitoes are sufficiently marked (if, for instance, they all have spotted wings), people forced to live or travel in malarious districts will ultimately come to recognise them and to take precautions against being bitten by them.

Before practical results can be reasonably looked for, however, we must find precisely—

(*a*) What species of Indian mosquitoes do and do not carry human malaria.

(*b*) What are the habits of the dangerous varieties.

I hope, therefore, that I may be permitted to urge the desirability of carrying out this research. It will no longer present any scientific difficulties, as only the methods already successfully adopted will be required. The results obtained will be quite unequivocal and definite.

But the inquiry should be exhaustive. It will not suffice to distinguish merely one or two malaria-bearing species of mosquito in one or two localities; we should learn to know all of them in all parts of the country.

The investigation will be abbreviated if the dangerous species be found to belong only to one class of mosquito, as I think is likely; and the researches which are now being energetically entered upon in Germany, Italy, America and Africa will assist any which may be undertaken in India, though there is reason for thinking that the malaria-bearing species differ in various countries.

As each species is detected it will be possible to attempt measures at once for its extermination in given localities as an experiment.

I regret that, owing to my work connected with *kala-azar*, I have not been able to advance this branch of knowledge as much during my term of special duty as I had hoped to do; but I think that the solution of the malaria problem which has been obtained during this period will ultimately yield results of practical importance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Times* reports that the University of Berlin celebrated on Thursday last the ninetieth anniversary of its foundation by Frederick William III. The oration was delivered by the retiring rector, Dr. Waldeyer, professor of anatomy, who took for his text the question, "Does the University of Berlin fulfil the mission entrusted to it by its founder?" As a contribution to the discussion of this question, he gave a learned and interesting account of the history of anatomical teaching in Berlin. Dr. Waldeyer is succeeded as rector by Prof. Fuchs, the distinguished mathematician.

THE Research Fellowships founded by the Salters' Company and the Leathersellers' Company for the encouragement of higher research in chemistry in its relation to manufactures, tenable at the City and Guilds Central Technical College, being now vacant, the Executive Committee of the City and Guilds of London Institute will, before the commencement of next session, consider applications and elect candidates. The grant made by each of the companies to the Institute for this purpose is 150*l.* a year. Copies of the schemes under which the Fellowships will be awarded may be had on application to the Honorary Secretary of the Institute, Gresham College, Basinghall Street, E.C.

A COPY of the twenty-third annual "Catalogue" of the Agricultural and Mechanical College of Texas has been received. All the departments of the College appear to be well equipped, and the buildings and grounds are of a very extensive character. The course of work at the College is designed to enable young men "to obtain that education and training which will fit them to take a leading part in the material development of the State; to become scientific farmers and horticulturists, familiar with the properties and needs of soils, the laws of plant growth, the principles of breeding, and, in general, with rational methods based on the revelations of modern science; to become mechanical engineers, draughtsmen, chemists, civil engineeers, competent to fill responsible positions in these callings—men fitted not only to meet demands made upon them, but to create such demand by pointing the way to progress and development."

THE Royal Naval Engineering College at Keyham was visited by members of the Institution of Mechanical Engineers during the recent meeting at Plymouth, and the excellent opportunities afforded for the efficient training of the engineer students, who are being instructed both theoretically and practically to enable them to become engineer officers in the Royal Navy, were seen. For the last eleven years Keyham has been the only Admiralty training ground for these officers. An entry is made once each year, during the first or second week in July, following a competitive examination held by the Civil Service Commissioners in the previous April. The period of training is five years. Throughout this time they undergo an educational course at the Royal Naval Engineering College under Prof. A. M. Worthington, F.R.S., whilst their practical training is obtained in the dockyard at Keyham, and the work they perform is as far as possible real. In a paper read before the Institution of Mechanical Engineers, Mr. R. Mayston pointed out that the facilities afforded at Keyham for the acquirement of a thoroughly practical training place the Royal Naval Engineering College in the foremost rank as an institution for obtaining a sound knowledge of mechanical engineering. The fact that as soon as possible after entry the student is employed on useful work, the various courses of instruction which are arranged to render the knowledge of marine engineering obtained as complete and as comprehensive as possible, the facilities afforded for acquaintance with running machinery, the constant contact throughout the training with experienced workmen, the frequent opportunities afforded for obtaining information from the officers who have charge of the training, all go to indicate that nothing is spared to make the training of the engineer student as complete as possible. It may, indeed, be accurately said that Keyham College furnishes an example of what technical education should mean, namely, a wise combination of theoretical and practical work.

HER Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships for the year 1899, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory

report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result in work of scientific importance.

	Nominating institution	Scholar
1	University of Glasgow	Robert John Tainsh Bell
2	University of St. Andrews	James C. Irvine
3	Mason University College, Birmingham	Henry Leonard Heathcote
4	University College, Bristol	Winifred Esther Walker
5	Yorkshire College, Leeds	Frederick William Skirrow
6	University College, Liverpool	Charles Glover Barkla
7	University College, London	Harriette Chick
8	University College, London	Henry James Tomlinson
9	Owens College, Manchester	Frank Austin Lidbury
10	Durham College of Science, Newcastle-upon-Tyne	William Campbell
11	University College, Nottingham	Louis Lownds
12	University College of Wales, Aberystwyth	James Travis Jenkins
13	University College of North Wales, Bangor	Robert Duncombe Abell
14	Queen's College, Belfast	William Caldwell
15	McGill University	William Brown McLean
16	University of Melbourne	Bertram D. Steele

The following scholarships granted in 1898 have been continued for a second year on receipt of a satisfactory report of work done during the first year :—

	Nominating institution	Scholar	Place of study
1	University of Glasgow	James Frank Bottomley	Owens College ; to proceed to University College, London
2	University of Aberdeen	Alexander Findlay	University of Leipzig
3	Mason College, Birmingham	A. H. Reginald Buller	Botanical Institute, Leipzig ; to proceed to University of Munich
4	Yorkshire College, Leeds	Harry Thornton Calvert	University of Leipzig
5	University College, Liverpool	Ernest Brown	Central Technical College, South Kensington
6	Owens College, Manchester	James Henry Smith	Owens College (*permitted under special circumstances*)
7	Durham College of Science, Newcastle-upon-Tyne	Arthur William Ashton	University College, London
8	University College, Nottingham	Austin Henry Peake	Cavendish Laboratory, Cambridge
9	Royal College of Science for Ireland	Robert L. Wills	Cavendish Laboratory, Cambridge
10	Queen's College, Galway	Hugh Ryan	University of Berlin
11	University of Toronto	William Gabb Smeaton	University of Leipzig
12	Dalhousie University, Halifax, Nova Scotia	Ebenezer Henry Archibald	Harvard University

The following scholarships granted in 1897 have been exceptionally renewed for a third year :—

	Nominating institution	Scholar	Place of study
1	University of Glasgow	James Muir	Engineering Laboratory, Cambridge
2	University of St. Andrews.	Harry McDonald Kyle	Gatty Marine Laboratory, St. Andrews, Laboratoire Arago, Banyuls-sur-mer ; Königliche Biologische Anstalt, Heligoland
3	University College, Bristol	Charles Henry Graham Sprankling	Owens College, Manchester
4	Yorkshire College, Leeds	Harold Albert Wilson	Cavendish Laboratory, Cambridge
5	University College of South Wales and Monmouthshire	Maria Dawson	Botanical Laboratory, Cambridge
6	University of Melbourn	Walter Rosenhain	Engineering Laboratory, Cambridge

IN connection with the article on the duties of provincial professors, which recently appeared in these columns, it is worthy of note that, according to the *Hochschul-Nachrichten*, 22 per cent. of the professors in the German universities are engaged in lecturing or laboratory supervision two to six hours a week, and 51 per cent. from seven to twelve hours. Of the associate professors 60 per cent. are engaged from two to six hours per week, and of the privatdocents 82 per cent. Only 4 per cent. of all privatdocents are engaged in lecturing or laboratory supervision more than twelve hours a week. As *Science* remarks, the leisure of the German associate professors and docents explains in large measure the amount of research work accomplished in German universities.

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxi, No. 3, July.—This number opens with a long memoir (64 pp.) by Dr. L. E. Dickson, entitled "Determination of the Structure of all Linear Homogeneous Groups in a Galois Field which are defined by a Quadratic Invariant." This is an attempt at a complete determination of this important type of groups. Dr. Dickson's work is familiar to the students of "groups" in this country by his papers in the *Quarterly Journal* (on the first hypoabelian group generalised, 1898), in the American *Bulletin* (the structure of the hypoabelian groups, July 1898, also of the *Bulletin* for February and May 1898), and in the *Proc. of the Lond. Math. Soc.* (the structure of certain linear groups with quadratic invariants, vol. xxx. pp. 70-98). Two new systems of simple groups are obtained in the present memoir, and thereby some results in the earlier papers are correlated and completed. (References are freely given to results obtained by other workers in this field.)—Upon the ruled surfaces generated by the plane movements whose centrodes are congruent conics tangent at homologous points, by Dr. E. M. Blake. The movements considered are thus defined. Upon a plane α' containing a conic C′ moves a coincident plane α, containing a conic C congruent to C′, in such a manner that C and C′ are always tangent at homologous points, *i.e.* C and C′ are the centrodes of the movement. The locus of a point rigidly attached to α is a curve of the fourth order when C and C′ are central conics, and of the third order when they are parabolas. The locus is in a plane parallel to α', and the same distance from it that the generating point is from α. The locus of a straight line carried by α and making an angle with it, is a quartic scroll when the centrodes are central conics, and a cubic scroll when they are parabolas. The object of the paper is to describe the forms of these scrolls, and the character and situation of their nodal lines and pinch-points. The results are to be regarded (1) as furnishing a method of mechanically generating certain cubic and quartic scrolls, and (2) as exhibiting the totality of line-loci of the movements considered. These results are believed, by the author, to be new.—The remaining two papers are by J. C. Glashan, and their nature is indicated by their titles, viz. "Quinquisection of the Cyclotomic Equation" (read, in abstract, at the British Association meeting of August 29, 1897, *cf.* Prof. Cayley's paper on the subject in vol. xii. of the *L. Math. Soc. Proc.*), and on the m fold section of the cyclotomic equation in the case of m prime. (Useful references are given to previous memoirs on the subject.)—Accompanying this number is an index to volumes xi.-xx.—The editorial staff is announced to consist of Prof. Newcomb, with the co-operation of A. Cohen, Frank Morley, Charlotte A. Scott, and other mathematicians.—This is strong enough for any work that may be placed before it.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Waters of the Salt Lake of Urmi." By R. T. Günther, M.A., and J. J. Manley, Daubeny Curator, Magdalen College. Communicated by Sir John Murray, F.R.S.

This paper contains an account of a physical and chemical investigation of the waters of the great salt lake of Urmi in Azerbaijan, North-west Persia. Samples of the water were

collected by Mr. R. T. Günther during his expedition to the lake last summer, and were examined by Mr. J. J. Manley in the laboratory of Magdalen College, Oxford. The specific gravity of one of the samples of the water at 15° C. was about 1·11338; its boiling point under normal conditions in a platinum bottle was 103·84° C., as determined by a form of platinum resistance thermometer. The refractive index (μ) was found to be 1·36110 by a method which the authors consider to be applicable to ordinary sea waters, and to be capable of yielding an indication of the physical nature of the water which is both more accurate and more readily obtainable than the ordinary specific gravity. The chemical examination was, with a slight modification, similar to that employed by Dittmar in his work on the composition of the ocean water collected by the *Challenger*. The hypothetical proximate composition of 100 parts of the total salts was calculated with the following results:—

Sodium chloride	86·332
Magnesium chloride	6·661
Magnesium sulphate	4·211
Calcium sulphate	0·988
Potassium sulphate	1·741
	99·933

A trace of barium was detected by the spectroscope. No iodine or bromine could be discovered.

It is to be hoped that the constitution of the lake water will be determined again at intervals of a few years, in order to show whether or not the salinity is undergoing any change, and if so, in which direction.

PARIS.

Academy of Sciences, July 31.—M. van Tieghem in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the death of M. Rieggenbach, correspondent in the Section of Mechanics.—Thermogenesis and use of energy by man in raising and lowering his own weight, by M. A. Chauveau. The positive work done by the animal motor is shown by experiment to take from the animal heat an amount quantitatively equal to the mechanical work produced. When the subject does negative work in the calorimeter, the heat produced is much greater than should arise from the normal physiological work of the organism.—On the law of pressures in gun-muzzles, by M. E Vallier. The author applies the formula previously given by him to the discussion of some experiments by M. Zaboudski, and introduces certain simplifications into his original expression.—Hypodermic impregnation in the *Haementaria castata* of Müller (*Placobdella catenigera* of R. Blanchard), by M. A. Kowalevsky.—On the annular nebula in Lyra, from observations made at the Observatory of Toulouse, by MM. Bourget, Montangerand, and Baillaud. The observations show unmistakably that very sensible changes of brightness have taken place in this nebula during the last twenty years.—Observations of β-Lyræ, made at the Observatory of Lyons, by M. M. Luizet.—On the variable star (D.M. + 12°·3557) of the Algol type, by M. Luizet.—On the methods of M. Loewy for the determination of latitudes, by MM. W. Ebert and J. Perchot.—The variations of the apparent horizon, by M. F. A. Forel. The possible error in the measurement of the position of the true horizon deduced from observation of the apparent horizon, is greater when the air is calm than when it is in motion, and greater than when the air is warmer than the water than the reverse; hence the observations are best taken in the morning.—On the equations of Pfaff, by M. E. O. Lovett.—On certain differential equations, by M. Henri Dulac.—On the changes of state of iron and steel, by M. H. Le Chatelier.—On the electric deformations of solid isotropic dielectrics, by M. Paul Sacerdote.—On the spectra of oscillating discharges, by M. G. A. Hemsalech.—With the oscillating discharges, a particular value for the self-induction of the circuit can be made to give a spectrum almost totally free from air lines, and showing very clearly the characteristic rays of the metals forming the electrodes.—On the isomeric states of chromium acetate: biacid abnormal violet acetate and a green abnormal monoacetate, by M. A. Recoura.—Action of magnesium upon saline solutions, by M. Georges Lemoine. Concentrated solutions of magnesium chloride rapidly disengage hydrogen when treated with magnesium powder, magnesia being simultaneously formed.—On the dissociation of the hexammoniacal cadmium chloride, by MM. W. R. Lang and A. Rigaut.—On the dissociation of mercurdiammonium iodide, by M. Maurice François. The compound of mercuric iodide and ammonia behaves similarly to the ammoniacal silver chlorides, the dissociation pressures showing that an intermediate compound $3HgI_2.4NH_3$ exists.—Action of sodammonium and potassammonium upon selenium, by M. C. Hugot.—On some acetonylacetonates, by MM. G. Urbain and A. Debierne. In the present paper details are given of the iron, manganese, cobalt, chromium, and aluminium compounds.—Action of mineral substances and organic acids upon the variations of resistance and modifications of the system, by MM. Charrin, Guillemonat, and Levaditi.—Immunity and specificity. Remarks on the preceding note, by M. Ch. Bouchard.—On the gluten and nitrogenous material of flour, by M. Balland. As flour grows older, the gluten appears to undergo a change, as it loses its coagulating properties, and is carried away in increasing quantity by washing with water.—Estimation of carbon dioxide at the summit of Mt. Blanc, by M. Maurice de Thierry. Details of estimations of ozone and carbonic acids carried out at Chamonix and Grand Mulets in August and September 1898.

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