THURSDAY, MARCH 15, 1894.

TROPICAL BOTANIC GARDENS AND THEIR USES.

Der Botanische Garten "'s Lands Plantentuin" 2 v. Buitenzorg auf Java. Festschrift zur Feier seines 75 jährigen Bestchens. Mit 12 Lichtdruckbildern und 4 Plänen.

Eine Botanische Tropenreise, Indomalayische Vegetationsbilder und Reiseskizzen. Von Prof. Dr. Haberlandt. Mit 51 Abbildungen.

IF one casts a glance over the more modern botanical literature, it will become evident that special activity is being manifested in that department, which we may term, in accordance with the German usage, the biology of plants. The day has long passed since the eminence of a botanist depended on the number of plants —dried or otherwise—which he could recognise at sight. But it is not so long ago since exaggerated importance was attached to a minute and exhaustive knowledge of details of the internal structure of plants, although, fortunately, the practice did not last long enough, nor did it become sufficiently general, to render the mental burden so heavy as the load which the older systematists had to bear. It is clear, however, that in each instance the science passed, and indeed had inevitably to pass, through a similar phase. The facts must be accumulated before they can be grouped, or before sound general conclusions can be deduced from them. Of course, the processes of accumulation and deduction were not severed in point of time; but the success of the latter process depends largely upon the industry with which the first has been carried out. The practical results have culminated in the perception of the meaning of a "natural classification," on the one hand, and in the evolution of a morphology which embraces and welds together the dry facts of pure anatomy into a consistent system, on the other.

But the morphology of to-day differs widely from that of a quarter of a century ago, both in its breadth and, also, to some extent, in the way in which it deals with its materials. Thanks to the labours of men like Sachs, Schwendener, and others, we are attaining to a broader conception of the principles which underlie and which govern the structure of plants, and we recognise that the most minute details of the organisation may be traced, whether ultimately or immediately, back to the responsive action of the protoplasm to the exigencies of its environment.

And perhaps few causes have been more efficient in promoting this change of front from the older formal views, than the extended experience of the manifold adaptations exhibited by plants which has been gained as the result of observation and travel in regions where the conditions of vegetation differ widely from those which obtain in Europe. As one shock after another assails our crystallised notions of the "typical form," we are driven to admit that our carefully drawn up categories may break down, and become obliterated, or fused beyond all recognition. The one fact which does stand out clearly through all, is the immense capacity for adaptive modification exhibited, not only by vegetation as a whole, but by individual organisms in particular.

If we find the plant more plastic in structure than we had supposed, the fault lies, not with nature, but in the too rigid formality of our ideas respecting what we had conceived to be typical forms of segmentation, and upon our too scanty recognition of the truth that bodily segmentation is after all only an expression of organisation. And as this principle becomes more clearly apprehended, the purely abstract and merely descriptive anatomy grows increasingly obsolete, and gives way to a more intelligent method of dealing with the subject. But if it is now possible for the best workers to seek out the meaning and the bearing of the new facts they discover, the merit of the older observers should not therefore be lost sight of. They laboured, and we have entered into their labours and are reaping the harvest which was not ripe for them to reap, which could not have even been sown, had their patience not been what it was. We can recognise, what they only saw dimly, that convergent and parallel lines of development have played an important part in the evolution of plants; that identical, or closely similar structural, form may be reached from independent and often widely different starting-points. Moreover, we see in this ultimate form, not the realisation of an ideal Type (which is really an outgrowth of nominalism), but the very practical expression of the fact that these evolutionary lines are those which best enable the organism, with its special inherent and inherited disposition, to cope most successfully with the complex difficulties of its environment, and to solve most successfully the problem of its existence. And these conclusions have been arrived at as the result of careful study, not merely of dried specimens and of pickled material, but also by the observation of living plants under their natural conditions of growth.

There can be no question that it is in the tropics that this last, and by no means least, important branch of a botanical education can be most suitably carried out. Nowhere else are the facts, which a study of the living organism will teach, more forcibly impressed on the mind than in those regions where the infinitely more complex conditions of existence demand a correspondingly greater variety of adaptation than is the case in our colder latitudes.

And with the establishment of gardens and laboratories in the tropics, it becomes increasingly easy for every botanist to avail himself of the immense advantages of a study of the vegetation of these parts of the world, not under the artificial conditions of stoves and hot-house culture, but under the widely different aspect of fierce mutual competition, in which they maintain their existence in a state of nature.

The publication of the interesting account of the justly famous garden and botanical station in Java, on the occasion of its seventy-fifth anniversary, comes at a peculiarly favourable juncture; and it is to be hoped that a perusal of its pages will do much to stimulate many botanists, who as yet lack a personal acquaintance

with tropical plant life, to go out and make use of the advantages now so easily within their reach.

The volume is a most interesting one; it tells of the difficulties which the enterprise of maintaining the "'s Lands Plantentuin" had to encounter and to overcome. Founded in 1817, it has succeeded in asserting its value, not only to the colony but also to science, and its importance in the latter respect is testified to by the number of botanists and others who annually visit it, as well as by the large amount of good work begun or carried out in its laboratories.

The volume, besides containing a description, illustrated with plans and photographs, of the garden and establishment at Buitenzorg, includes also an account of the various experimental stations which have arisen as offshoots from it. It contains, further, a useful *résumé* of the numerous investigations which have been conducted in connection with the gardens, and which have been published in various journals and reports. There is interesting and valuable information given concerning the culture and uses of economic plants.

But the gardens in Java, like our own colonial establishments of a similar nature, do not exist solely for scientific or ornamental purposes. Their use to the colony, and their importance in serving as a means for introducing and experimenting on the cultivation of vegetable products suitable to the country, cannot be overrated. The present writer recollects a well-known Ceylon planter observing, *à propos* of the garden at Peradeniya (in Ceylon), that it would have abundantly justified both its existence and its expense had it done nothing but serve as the means of introducing the cultivation of Cinchona into the island, during the interregnum which prevailed between the collapse of the coffee industry and the rise of tea. And this remark was the more striking, as it was made some years after experience had been shown that the growth of Cinchona could not be profitably pursued any further. The plant had, however, served its turn, and had saved the country from possible bankruptcy.

Amongst the list of visitors to the Java garden, one notices the name of Prof. Haberlandt, and he has given us his impressions of the tropics in a most delightful volume. It is true that there is not, perhaps, much that is actually new to any one who is versed in modern botanical literature, but Dr. Haberlandt tells what he has to say in a charmingly enthusiastic and artistic manner; and his pages are illustrated with impressionist sketches which convey an excellent idea of the character of the objects portrayed.

The book is what it professes to be—an account of a "botanical excursion"; but besides the chapters on epiphytes, mangroves, hill and desert floras, there are sections devoted to observations on the natives and their ways, as well as others on the climate and meteorology of Java. The chief value of the volume lies in the perception of things which will, or should, attract the eye of a traveller new to the tropics; and while the work may be praised as one full of matter of considerable general interest, it may be especially commended to those who are themselves about to undertake a journey to the East.

J. B. F.

THE TELEPHONE.

A Manual of Telephony. (The Specialists' Series.) By W. H. Preece, C.B., F.R.S., and Arthur J. Stubbs. (London: Whittaker and Co., 1893.)

ONLY about four years ago we reviewed a treatise entitled "The Telephone," by Mr. W. H. Preece and Dr. Maier, which up till recently was the chief manual on its special subject in English. The rapid advance of telephony, however, had rendered large portions of that work completely out of date, and Mr. Preece, with, this time, Mr. A. J. Stubbs as co-worker, has completely rediscussed the subject, and replaced the former treatise by the present.

The work is divided into six parts, and each of these again into some half-dozen chapters. Part i. deals with the construction and mode of action of telephones and transmitters, ii. with general apparatus and switches, iii. with simple exchange stations, iv. and v. with the more complicated and extensive exchanges, their switchboards, &c., and vi. with the construction of telephone lines and cables.

What we said about the merits of the former book we have here to repeat. Nowhere else in English have we so full and accurate descriptions of telephones and transmitters, or so practical and detailed accounts of telephonic apparatus, and the mode of carrying on the work of telephone exchanges. This, by far the greater part of the book, is extremely well done, and we have no doubt that as a practical guide and help to the telephonic engineer, it will be of very great value.

Anything we have to say in the way of criticism on the contents of the book resolves itself in the main into a few remarks on the first chapter and the last, in both of which we find sections that seem to require slight improvements.

In chapter i. we have a very brief account of current induction. This is clear in general, but one or two statements ought to be amplified in order to prevent misunderstanding. On p. 9 it is affirmed that the intensity of the magnetic force in the field of a conductor carrying a current varies inversely as the square of the distance from the conductor. This statement cannot be said to be true except of a short current element, in which case the magnitude of the force is as stated, and its direction at right angles to the plane determined by the element and the line joining it to the point at which the force is being considered.

The conductor contemplated in the next sentence seems to be a straight one of unlimited length, for in other cases the lines of magnetic force are not *circles* round the wire, unless, of course, the wire be very thin, and the field at points only which are very close to the wire be considered. In the case of a single long straight conductor the magnetic force varies inversely as the distance from the conductor.

Again, it is stated in p. 11, that "there are two classes of induction": that is, induction of currents produced by the variation in position or magnitude of currents in neighbouring conductors, and induction due to changes in the magnetic field in which the conductor acted upon is situated. Of course the authors do not mean to assert

that these are really distinct, for both can be accounted for by changes in the magnetic field in which the conductor is situated. The field in one case is produced by magnets, in the other case by current-carrying conductors. It would have been well to point out this connection between the two things; in fact, the idea of a conductor carrying a current as equivalent to a certain magnetic distribution is in many cases very helpful in enabling the nature of the magnetic fields of conductors to be estimated, and the conductors to be properly arranged for the purpose in hand.

We took exception before to the statement in p. 12 that "the energy W of a current in a coil at any moment is expressed by the product of the current (C) and the electromotive force (E) that is W=EC," and we are sorry it has escaped revision. Of course the authors are perfectly aware that EC is in reality power or activity, not energy, and merely use a very common but inaccurate mode of speaking of the quantity EC. The energy of the current C in a coil is $\frac{1}{2}LC^2$, where L is the self-inductance of the coil, and the expression ought to be reserved for this quantity.

Experienced electricians like the authors may and do avoid error from the adoption of popular but inaccurate language; but the mental confusion of power with energy is very common, and has led to the most absurd conclusions as to the electrical efficiency in the circuits of generators and motors. The misinterpretation, which used to be so common, of the so-called law of Jacobi is a case in point. In their anxiety for brevity of statement and intelligibility to practical men, the authors, it seems to us, run some risk of being seriously misunderstood.

The chapter on the theory of the Bell telephone is lucid, and gives a very good account of the various theories that have been advanced from time to time regarding molecular action, &c. Mr. Heaviside's simple explanation (given also, if we mistake not, by Mr. Trouton) of the part played by the permanent magnet in the telephone is stated at p. 28.

Chapter xxxi., on the limiting distance of speech, contains a clearly expressed summary, of course without any attempt at quantitative discussion, of the conditions of working an ordinary submarine or underground cable, of which the true theory, and therefore also, it may be remarked, the practice, was given long ago by Lord Kelvin. Mr. Preece has had an immense amount of practical telephonic experience; but we are not convinced that in circuits composed of non-magnetic metals, with rapid alternations of the kind concerned in speech-telephony, the influence of electromagnetic inertia is so slight as the authors seem to regard it.

We heartily commend this work to the technical readers to whom it is addressed. The account of telephone practice which it contains is worthy of all praise, and it will prove not only a most useful work of reference, but from its size a readily carried about and consulted handbook for all engaged in such work. We wish it all success, and a speedy reissue in a new edition, when the few improvements we have suggested may easily be made.

A. GRAY.

GÜNTHER'S BACTERIOLOGY.

Einführung in das Studium der Bakteriologie mit besonderer Berücksichtigung des mikroskopischen Technik. Für Aerzte und Studirende. By Dr. Carl Günther. Third edition, 1893. 376 pp. (Leipzig: Georg Thieme.)

ACTIVITY in the bacteriological world shows no signs of decreasing, and whilst text-book after text-book make their appearance, new editions of older works follow one another in rapid succession.

The first edition of Dr Günther's book was published in 1890, and now we have already before us the third edition. A review of the second edition having appeared in these columns in March, 1893, it will only be necessary to draw attention briefly to some of the principal additions and alterations in the present volume.

The fact that 100 pages of new material have been added, is in itself a guarantee that the author has not failed to incorporate a great deal of fresh work, and, indeed, on going carefully through the letter-press, the reader is struck by the extreme care and thoroughness with which the revision has been carried out.

The section introductory to the special description of pathogenic bacteria has been increased from nineteen to thirty-one pages, and now contains a comprehensive review of the recent work on the subject of immunity. There is, however, no mention of the experiments in this direction which have been made with the glanders bacillus by Kresling, Semmer, and Wladimirow and Semmer, and which appeared early last year in the Russian journal, *Archives des Sciences Biologiques*, issued by the Imperial Institute of Preventive Medicine in St. Petersburg. In the account of the tubercle bacillus we find five additional pages, and a more moderate view taken of the value of tuberculine as a cure for consumption than appeared in the previous edition.

But, as was to be expected, it is in the description of the cholera comma bacillus that the largest amount of fresh material has been incorporated, close upon twenty extra pages having been found requisite to bring the work up to date. The various methods for the correct diagnosis of the cholera organism are very fully given, as well as the numerous devices for its isolation from water when present with other bacteria. Amongst the more important comma-shaped organisms endowed with pathogenic properties is included the *vibrio berolinensis*, which was found last summer by Neisser in the Berlin water supply. The account given of this vibrio is necessarily very slight, for Neisser's paper had not yet been published in full. This organism resembles the cholera comma bacillus very closely, and appears to be distinguished from the latter only in the appearance of the colonies on gelatine plates; but these differences are so slight, depending chiefly on the finer granulation of the contents and the less irregular contour of the colonies, that it is difficult not to regard it as a variety of the cholera vibrio.

Amongst the twenty-four saprophytic bacteria mentioned, the nitrifying organisms are conspicuous by their absence. The investigations made both in this country and on the continent have now firmly established the existence and individuality of these organisms, and it is

difficult to understand the omission, especially as space has been found for such uninteresting microbes as the *spirillum rubrum* and others.

The photographic illustrations, whilst remaining the same in number, have been in some cases changed; three of the new ones are devoted to comma-shaped bacilli resembling the cholera vibrio, one of them being the *vibrio aquatilis*, recently isolated by Dr. Günther himself from water, whilst two new plates have been added of the colonies of the cholera bacillus in different stages of development.

The volume is undoubtedly one of the best introductions to the study of bacteriology which has yet been produced. G. C. FRANKLAND.

OUR BOOK SHELF.

Lectures on Mathematics. Delivered from August 28 to September 9, 1893, at North-Western University, Evanston, Ill., by Felix Klein. Reported by Alexander Ziwet. (London: Macmillan and Co., 1894.)

IN these twelve lectures, which are excellently reported by Mr. Ziwet, it was the intention of Prof. Klein to present his hearers with an account of some of the modern developments of mathematics, particularly in those branches in which the lecturer himself has worked. Each lecture is therefore a unit in itself, and the whole work thus covers a wide range of subjects. The nature of the case precludes exhaustive treatment; the lectures are cyclopædic in character, and the copious references will please the readers who may wish to look up the original memoirs for details. It would be useless in a short review to attempt to do more than briefly describe the matter contained in these ninety-eight pages. We notice that geometrical methods of research are particularly emphasised, and their usefulness demonstrated in widely different territories. The first four lectures are purely geometrical in character, being devoted to the work of Clebsch (i.), to the geometrical side of the researches of Lie (ii. and iii.), and to the modern results on the real nature of algebraic curves and surfaces (iv.). Chapter v. treats of the application of geometrical methods to function-theoretical questions, illustrated by the case of the hypergeometric function. In chapter vi. Prof. Klein discusses the nature of space-intuition and the relation of mathematics to the applied sciences. The following chapter contains an account of Hilbert's simple proof of the transcendency of the numbers e and π, and chapter viii. contains a beautiful application of geometrical methods to certain problems of the number theory. By a simple construction the author has given to the composition of binary algebraic forms, and to the ideal numbers, a high degree of simplicity and clearness. The remaining chapters treat successively of the solution of higher algebraic equations, hyper-elliptic and Abelian functions, and non-Euclidian geometry.

Appended also is a translation of the article by Prof. Klein, entitled "The Development of Mathematics at the German Universities," written originally for the section "Mathematik" in the work "Die Deutchen Universitäten" (Berlin: A. Asher and Co., 1893).

English mathematical readers have to thank Mr. Ziwet for laying before them in a neat form the residue, so to speak, of this Evanston Colloquium.

Elementary Trigonometry. By H. S. Hall, M.A., and S. R. Knight, B.A. (London: Macmillan and Co., 1893.)

IF the knowledge of the subject under consideration varied directly as the number of text-books on that subject, there is no doubt that elementary trigonometry would be running very high for the first place among school-books. The law of the survival of the fittest, in its manifold forms, is appropriate for text-books, if for anything, and it is perhaps good that this is so, as we should soon be flooded out by their excessive number. Of late, however, books for beginners on this branch of mathematics have been of a high standard of excellence, and the one before us is no exception. The joint authors are well known for their school books on algebra, and their great experience in teaching has given them a real insight into "how to teach." To briefly enumerate the points which the authors name as special to this book, we may commence by saying that only those elementary parts have been handled which do not require the use of infinite series and imaginary quantities. Special prominence is given to examples, &c. on easy identities and equations, to enable the beginner to thoroughly master the fundamental properties of trigonometrical ratios. The subject of radian or circular measure is with advantage referred to later. Logarithms are fully dealt with, and special attention has been given to the exposition of problems on heights and distances. The examples in all chapters are numerous and typical. This book can safely be recommended to beginners, and it may, besides imparting to them a sound elementary knowledge of the subject, ingraft an intelligent interest for more advanced study.

LETTERS TO THE EDITOR.

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

Great Auk's Egg.

"A THANKLESS task the truth to tell," says a minor poet. In my note (*supra*, p. 412) I tried to do it in an impersonal way; but Mr. Harting, to my regret, introduces names (p. 432) while falling back upon a statement which was controverted three years ago, and is unsupported by fresh evidence. On some accounts I highly esteemed the late Mr. Bond, with whom I was acquainted for nearly forty years, and I am very sorry to impugn the accuracy of his memory: it is well known that he never kept a note of any specimen in his collection. I express no doubt that his tale of 1860 was correctly reported, and I have none as to the correctness of the report of the tale, purporting to be the same, told by him in 1889 (in Mr. Harting's presence, if I am not mistaken), and carefully taken down. A copy of this, now before me, shows that in the interim the tale, as tales are wont, had developed. In the later version the seller of the egg was "a fisherman who had been on a whaling ship"; but I hold that neither version is "deserving of consideration."

As to my own story my recollection is clear. I heard it more than once from Mr. Yarrell; and in its time it was common talk among the egg-collectors of those days, of whom I am one of the last. Not six months ago I was talking of it with the late Mr. Henry Walter, whom we have since lost. I find it supported by a memorandum made by me (I think) in 1862, which was based (I know) on one of earlier standing, though that is not forthcoming. But I have positive evidence in a letter written by Mr. Wolley from Lapland on February 5, 1857, in reply to one just received from me giving him particulars of the sale of Mr. Yarrell's collection in December, 1856. Therein Mr. Wolley, who on a point like this could not err, recalling its lately deceased possessor, and remarking on the change of owners, wrote of "Yarrell's eyes as he told the often repeated story of his buying the egg in Paris—this very egg now in Gardner's hands."

To some it will seem a small matter where Mr. Yarrell bought the egg; but to those who have tried to tell the Garefowl's true history, it is disheartening to find belief sought for the Boulogne version, as it shows how their trouble has been thrown away. No one with any knowledge of facts could suppose that the

species had a breeding-place near which any whaling ship, in the present century at least, ever went; and those who accept this version recur to errors that were refuted by Prof. Stenstrup more than five-and-thirty years ago. ALFRED NEWTON.

Magdalene College, Cambridge, March 10.

The Decomposition of Liquids by Contact with Cellulose.

THE recent work of Dr. Gore, on "The Decomposition of Liquids by Contact with Powdered Silica," presents a striking resemblance to what has from time to time been ascertained with such substances as cellulose. In fact, the properties ascribed to silica are very likely shared under some conditions by colloids in general, whether they be "organic" or "inorganic" bodies. Cellulose, when immersed in diluted solutions of some metallic salts, has the power of abstracting from them a certain quantity of the salt for which it may have no chemical affinity as ordinarily understood. The amount of salt abstracted is dependent upon several conditions: the degree of dilution of the salt; the ratio of cellulose to salt; the ratio of cellulose to weight of solution; the temperature; the physical condition of the cellulose; and the chemical constitution of the cellulose.

Let us, in order to eliminate the last-named condition, confine ourselves to pure cellulose or cotton. When cotton wool is placed in a solution of a metallic salt, it abstracts the salt from the solution until equilibrium is established. If we regard the part played by the cellulose in the light of Witt's theory of solid solution, the amount of salt retained by cellulose is conditioned by the relative solubility of the salt in water and cellulose, and the ratio in which the three exist together. If water is now added, a certain amount of the salt dissolved by the cellulose will become resoluble in the water. Also, if the solution be concentrated, the fibre will generally take up a further quantity. In some cases, however, the amount of salt taken up by the cellulose is not imparted to the solution on dilution. This is probably due, as in the case, I believe, of the ferric salts, to dissociation in solid solution. The dissociated base being insoluble (in water) is retained by the cellulose on addition of water, whereas the acid may be dissolved. The physical condition of the same cellulose has a great influence upon the amount of salt which it is capable of dissolving. If cellulose be finely disintegrated, it behaves differently from that in which the ultimate fibres remain intact.

The cotton fibre, when seen under the microscope, is found to vary considerably in shape and size. It is probable, then, that each fibre has a certain constant of absorption peculiar to itself. Cellulose, when rendered anhydrous by placing it in a water-bath or desiccator, is found to rise considerably in temperature when exposed to a damp atmosphere. This may, however, be caused by the liberation of heat, due to the condensation of moisture from the gaseous state. If so, no rise of temperature would be noticed in plunging anhydrous cellulose into water. It appears, however, that cellulose is susceptible of a certain degree of hydration in coming in contact with water, which is probably attended by the liberation of heat. I have found that dried cellulose placed in a damp atmosphere remains at a higher temperature than its surroundings so long as it is taking up moisture, which appears to be greatest when the rate of absorption is greatest. By the time it has recovered its normal condition of moisture it has sunk to the temperature of its surroundings.

The above considerations seem to point out that cellulose, like silica, exhibits well the phenomena of solid solution.

C. BEADLE.

Physiological Psychology and Psycho-physics.

IN a note contained in your issue of January 11 (p. 252), upon the teaching of psycho-physiology in University College, I notice two errors; which, as they are, unfortunately, very wide spread, you will perhaps allow me to correct.

(1) "Physiological psychology" and "psycho-physics" are not one and the same thing. The former science is a specially limited and specially enlarged psychology. Limited: in that it pays more attention to experimentation carried out by physiological methods than to any other psychological experimentation. Enlarged: in that it discusses the most important problems relating to the physical basis of mental life. These latter problems belong to psycho-physics, which is the science of the relation of "mind" to "body."

(2) A "practical course in psycho-physiology," which confines itself to the senses, is not a representative or adequate course, as the note implies. The psycho-physics of sensation is no more the whole of psycho-physics than the physiology of the sense-organs is the whole of physiology, or the psychology of sensation, perception, and idea, is the whole of psychology. A historical accident has led to this popular restriction of the term; but a glance at the literature of the science will show its wrongness. E. B. TITCHENER.

Cornell University, February 16.

DR. TITCHENER'S criticism of my note strikes me as a little strange. First of all, he objects to my speaking of "physiological psychology *or* psycho-physics," maintaining that they are different, and then proceeds at once to subsume psycho-physics under physiological psychology. As a matter of fact, psycho-physics, as understood by Fechner, the coiner of the word, and generally up to quite recent times, does not directly refer to the relation of the organism to psychical phenomena at all, but to the relation between the (extra-organic) stimulus and sensation, though of course this inquiry leads on to two further inquiries: (*a*) the relation of the extra-organic to the organic process, and (*b*) the relation of this last to sensation. Münsterberg and others now use "psycho-physical" for relations generally between neural processes and psychical processes, but the change of meaning is a little confusing. Anyhow, it will be seen that there is no general agreement about the expressions "physiological psychology" and "psycho-physics," such as Dr. Titchener's note suggests.

I may add that in using "or" rather loosely (as I felt justified in doing in a short note), I did not mean to imply that the two branches of inquiry were identical. I wanted to call attention especially to the fact that the course would go systematically over an experimental inquiry *into the senses* which would necessarily include reference to stimulus, and so psycho-physics, and reference to nerve process, and so physiological psychology. As to Dr. Titchener's second "error," I find him hypercritical. I am well aware that psycho-physiology covers more than the senses, and I think that nothing which I say implies the contradictory of this. There can surely be a practical course on a subject which does not exhaust all divisions of the subject. As a matter of fact, however, Dr. Hill *is* taking up other branches, as reaction-time experiments. I was content to emphasise the fact that *the senses* would be systematically examined; and all who know what psycho-physiology has done, know that by far the larger part of the really fruitful work leading to definite results has been done in the investigation of the senses. THE WRITER OF THE NOTE.

March 3.

THE LAST GREAT LAKES OF AFRICA.[1]

ADMIRABLY translated as it is, this book scarcely retains a trace of its previous existence in a foreign tongue; but although the translator states in the preface that she has slightly condensed the original matter in bringing it to its present form, we believe that much more rigid compression might wisely have been applied. Earlier books have placed later travels in Eastern Equatorial Africa so prominently before the British reader, that much of the ground which was full of fresh interest when the two gallant Austrians traversed it is now familiar, and its features common-place. Thus a great part of the first volume, detailing the troubles of inexperienced and, perhaps, somewhat imperious Europeans in organising a large caravan at Zanzibar and Pangani, and in crossing the coast-lands and ascending the slopes to Kikuyu, might well have been omitted without lessening the thrilling interest of subsequent chapters.

The expedition, primarily a sporting one, was also in large measure exploratory, and if the pursuit of big game, and the hairbreadth escapes of the hunters

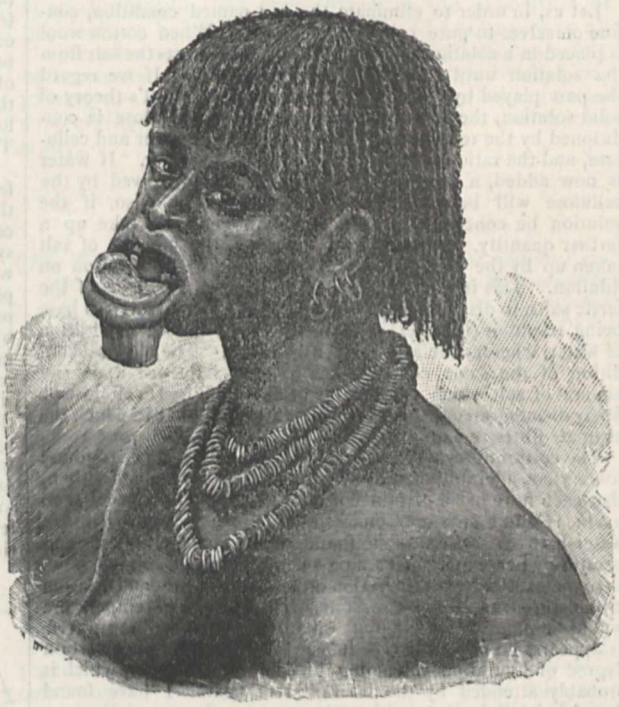
[1] Discovery of Lakes Rudolf and Stefanie. A Narrative of Count Samuel Teleki's Exploring and Hunting Expedition in Eastern Equatorial Africa in 1887 and 1888. By his companion, Lieut. Ludwig von Höhnel. Translated by Nancy Bell (N. D'Anvers). With 179 original illustrations and five coloured maps. In two vols. (London: Longmans, Green, and Co., 1894.)

occupy a more prominent place than the physical character of the country and the nature of the people, the author doubtless consults the taste of the majority of his readers in the arrangement. Besides, the really valuable scientific results, due almost entirely to Lieut. von Höhnel's skill and enthusiasm as an observer, are well known to the scientific world from the admirably precise memoir published shortly after the return of the expedition. The casual reader of this more popular work would hardly realise the magnitude of the services rendered to African geography by the few modest references to observations and collections made by the author. Two appendices summarise Count Teleki's "bag," and the natural history collections. The latter comprise 12 reptiles or amphibia, 247 species of Coleoptera, of which 60 are new to science, and 59 species of Lepidoptera, including 15 that are new. The botanical collections, named by Prof. G. Schweinfurth, include 171 species of phanerogams illustrating more than 50 orders, and over 60 mosses and lichens, a large proportion of them being new to science.

While it is well to remember the solid contributions to different branches of science made by the expedition, the interest of the popular record inevitably centres in the larger field of exploration, and especially in the splendid discovery which supplies the title. The whole first volume is filled with the journey through Masai-land and the partial ascents of Mts. Kilimanjaro and Kenia, which in the main confirm, although they occasionally extend, the earlier records of Joseph Thomson and Mayer. Volume ii. conducts the party from Lake Baringo into the heart of the mysterious region which separates the land draining to the Victoria Nyanza from the Galla country and Somaliland. The march northward was a work of vast difficulty, and its success says much for the perseverance and foresight of the leaders, for food was very scarce, and water often altogether wanting, while the native guides frequently caused much trouble by their ignorance of the country. Many curious facts are mentioned incidentally as to camp management. When the supplies ran short, one of the Zanzibari head-men himself hit on the device of paring down the wooden bowl which was used to measure out the rice, so that day by day the rations were reduced but the measure was always full. The Zanzibaris being somewhat strict Mohammedans, and having many prejudices, were difficult to cater for; they would only eat elephant flesh when driven by severe hunger, and threatened to starve rather than devour donkey.

The reward for the increasing hardships came with the discovery of Lake Rudolf, a noble sheet of water 170 miles in length, probably the last of the greatest lakes to be found in Africa. It lies in a region of strong volcanic activity; a great mountain was seen, though not reached, from the crater of which a cloud of smoke ascended, and the scenery of some parts of the lake-shore suggest an analogy with the lunar surface. The water was brackish, or rather alkaline, containing sodium carbonate in solution, so that when treated with tartaric acid it made a refreshing drink. The shores were absolutely barren, affording no food for cattle, and showed marks of recent great upheaval, while the lake itself was without outlet. After struggling along this land of volcanic gloom at imminent risk of death by starvation, the expedition reached the north end of Lake Rudolf, crossed a fertile region inhabited by hospitable tribes, and discovered Lake Stefanie, a smaller volcanic basin, the water of which seemed to be rapidly diminishing in volume. Here it was necessary to return; there were no maps of the country where the expedition was; no certainty of being able to gain the coast by the north or east, and failing supplies of goods for barter compelled a retreat on Lake Baringo and thence to Mombasa. The tribes of the Lake Rudolf region presented many points of great interest, and still remain an ethnological problem, although the observations of Lieut. von Höhnel on his expedition with Mr. Astor Chanler, from which he has recently been invalided home, may be expected to throw

Reshiat Woman.



Buma-Marlé Woman.

much new light upon them. The contrast between the handsome and comparatively fair Reshiats and the ill-favoured and artificially deformed Buma and Marlé people is singularly marked, although the tribes reside near each other. The Buma-Marlé women wear lip ornaments, closely resembling those of the Botocudo and other savages of the Amazon basin. Dwelling on the west side of Lake Rudolf, the Turkana tribes set some of the most curious fashions in hair-dressing that even the African mind has devised.

For some time to come this district, first entered by Count Teleki and Lieut. von Höhnel, will be the base for new exploring journeys of high importance; but it is difficult of access, and all those who have tried to follow in the footsteps of the pioneers, have so far been obliged to turn back unsuccessful. H. R. M.

THE BEETLES OF NEW ZEALAND.[1]

TIMES have changed since the founders of entomology considered it sufficient to use the words "in Indiis," when they were unacquainted with the locality of an insect they were describing; nor would it be possible now to publish a volume of "Insects of India," like Donovan's, issued no longer ago than the beginning of the present century, in which many of the species represented on the plates are conspicuous South American or African butterflies. At present it is hardly considered lawful to describe an insect without an exact locality, and the number of species has increased to an extent of which the older entomologists never dreamed. We cannot at present be acquainted with much fewer than 300,000 species of insects from all parts of the globe, and yet none but a few, even among entomologists themselves, have any conception of how much yet remains to be done before our knowledge of the insects of the world can be considered anything like complete; and some entomologists of great experience now mention ten millions as a mere guess at the approximate number of existing species.

But our knowledge of the insects of various countries is now being largely extended by the publication of local monographs of different groups of insects, mostly, but not always, relating to the *Lepidoptera*. These monographs are of the greatest value as a basis for future research, and are especially important in the case of islands for several reasons.

Firstly, an island has a restricted area, and hence its fauna forms a compact whole; nor can there usually arise much difficulty in ascertaining what species are really indigenous.

Secondly, from the restricted area of islands, and the facilities they offer for colonisation and cultivation, the bulk of the native fauna and flora is peculiarly liable to be exterminated, not merely from the advance of cultivation, with its usual accompaniments of clearing of forests and drainage of marshes, but from the irruption of powerful competitors in the shape of dominant, if not almost cosmopolitan species from abroad.

Thirdly, many insular species, especially in the case of oceanic islands, are endemic, being peculiar to the locality, and found nowhere else in the world, and are thus liable to be lost to science for ever. Nor are we yet in a position to estimate the value of such species. It is even not impossible that in some cases, at least, they may be the last remnants of the productions of some long-vanished continent, and they may some day prove of service in helping us to map out the rough features of the former geography of the world.

[1] "New Zealand Institute. Manual of the New Zealand Coleoptera." By Captain Thomas Broun. Parts v., vi., vii. Published by the Board of Governors. Wellington, New Zealand. (Government Printing Office: Samuel Costall, 1893.)

The volume before us, although issued as parts v., vi., and vii. of Captain Broun's "Manual of New Zealand *Coleoptera*," is really a supplement to the well-known and extremely useful work published by the Geological Survey and Museum Department between 1880 and 1886. These parts, issued as i.–iv., comprised 973 pages, and included descriptions of 1756 species. The present supplement continues the pagination to 1504 pages, and includes descriptions of 836 new species, thus raising the number of New Zealand beetles to 2592; and Captain Broun considers that over 700 species still remain undescribed. It will therefore be seen that, notwithstanding the extremely insular character of the New Zealand fauna, there is every reason to believe that the number of species of *Coleoptera* will ultimately far exceed that of our British beetles, which are not now considered to amount to quite 3000 species.

Dr. Hector, the Director of the Colonial Museum, Wellington, remarks, in his preface to Capt. Broun's work:

"Of the present additions, 660 have been described by Captain Broun, 172 by Dr. David Sharp, four by Mr. Matthews, and one by M. Fauvel; and in order to place these species in proper systematic position, Captain Broun has found it necessary to establish several new genera."

It is impossible to criticise a work like this, consisting almost entirely of technical descriptions of genera and species. A very few corrections to the former parts of the work are prefixed to this volume, in addition to a not very formidable list of errata. It is obvious that there could be no room in a book of this kind for more than a few of the most important comments which might be made on the earlier portions.

There is a good systematic index at the beginning of the volume, and we do not think that as there is no synonymy, the absence of an alphabetical index is of any importance. But we should have liked to have seen an index of localities, for although the places mentioned may be, and probably are, familiar to New Zealand colonists, yet other coleopterists may wish to know, at least, in which island each insect was taken; and in the case of mountain species, the approximate altitude, if known, should be recorded. We cannot have too much or too exact information on matters of this kind. W. F. KIRBY.

NOTES.

THE preliminary arrangements for the seventh International Congress of Hygiene and Demography, to be held at Budapest from the 1st to the 9th of next September, are well advanced, as many as 440 papers having already been promised. Most of these treat of hygienic subjects, but 78 papers are devoted to demography. The Congress will be opened by the Archduke Karl Ludwig.

THE Government has decided to place the direction of the Customs and Inland Revenue Laboratories under one administrative chief, to be styled the Principal Chemist of the Government Laboratories. The Principal Chemist will also receive references from the Board of Agriculture, the Local Government Board, and other Government departments. The appointment, which is in the gift of the Treasury, has been offered to, and has been accepted by, Prof. Thorpe, F.R.S., who thereby vacates the Chair of Chemistry in the Royal College of Science, which he has held since 1885.

DR. ARTHUR W. BISHOP, late Assistant Professor at the Heriot-Watt College, Edinburgh, has been appointed, by the Secretary of State for India, Professor of Chemistry in his Highness the Maharajah of Travancore's College at Trivandrum, Travancore.

DR. W. J. RUSSELL, F.R.S., has been elected President of the Institute of Chemistry, in succession to Dr. W. A. Tilden, F.R.S.

DR. F. DAHL has been appointed Professor of Zoology, and Dr. F. Shütt Professor of Botany, in Kiel University.

DR. K. AUWERS, Privat-docent in Heidelberg University, has been appointed Professor of Physical Chemistry.

A COLLECTION of botanical specimens from the Pamirs, made by Captain Younghusband, has been added to the Herbarium at the Saharanpur Government Botanical Gardens.

THE *Pioneer Mail* says that direct telephonic communication was established between Calcutta and Nagpoor, a distance of 750 miles, on February 18. Messages were successfully interchanged between the two stations.

IT is said that negotiations are in progress between Dr. Billings, on behalf of the United States Surgeon-General's Office, and the family of the late Prof. August Hirsch, of Berlin, for the purchase of the library left by the latter, which consists of about 10,000 volumes.

GALES or strong winds have occurred with great persistency over our Islands during the past week. On Saturday morning, the 10th instant, a storm centre lay off the north of Scotland, and between that time and Sunday morning a very severe gale was experienced in the north and west, while upwards of an inch and two-tenths of rain fell at Stornoway. On Monday afternoon another severe storm reached our south-west coasts, and on the succeeding night passed in a north-easterly direction to the North Sea. This disturbance was also accompanied with heavy rainfall at many places; at Holyhead it amounted to three quarters of an inch. The rainfall lately in Scotland has been greatly above the average; the excess in the north of Scotland is 8·6 inches since the beginning of the year.

THE report of the Berlin branch of the German Meteorological Society for the year 1894 contains an investigation by its President, Prof. G. Hellmann, on the temperature in and outside the town of Berlin. The influence of a large number of houses on the temperature is very marked, and Dr. Hellmann has been at great pains to secure trustworthy results; the instruments are carefully compared and exposed at several stations in properly constructed screens, and are in charge of persons interested in the work. The mean yearly temperature in the town is found to be nearly 1° higher than in the suburbs, the greatest difference occurring in the warmer season (March to August), and the least during winter. But in time of severe frost the difference has amounted to as much as 14°. The greatest variation naturally occurs in the evening, when the houses radiate the heat obtained during the day-time; in summer time this difference amounts to 2° or more, and on calm evenings may even amount to more than 5°; the temperature curve inside compared with that outside the town shows quite a different rate of fall.

A PAPER on the Texan monsoons was recently read before the Philosophical Society of Washington by Prof. M. W. Harrington. In order to ascertain the existence, locality, and character of recurring winds, maps were constructed from the tri-daily observations of the Weather Bureau, to exhibit the most frequent winds for each month of the year, and these maps showed a distinct seasonal change in wind direction in several localities of the United States. The southerly winds, or summer monsoons, in Texas first appear distinctly in March, and their area is most extensive from May to October, when it occupies about 500 miles in longitude and about 1000 miles in latitude, extending to the Canadian boundary. The northerly winds or winter monsoons first appear distinctly in December, and continue until the end of February, occurring for the most part under anticyclonic conditions to the north of Texas. They sometimes combine with the well-known "northers," causing a great fall of temperature. These monsoon winds play a very important part in the climate of Texas; the southerly winds bring coolness when it is most needed, while the northerly winds, although not so favourable, are not less so than the prevalent westerly winds to the northward of that State.

THAT the luminosity of a candle can be calculated direct from the dimensions of its flame, is the rather striking theorem of Herr P. Glan, who gives the results of his measurements in the current number of *Wiedemann's Annalen*. The volumes of the bright portions of various candle flames were measured by taking the length by means of a scale placed behind the flame, and the breadth at various points by gauging it with calipers or compasses. These bright portions have approximately the shape of cones, each of these cones being penetrated from below by a truncated cone, consisting of the dark central portion. The difference between the volumes of the two cones gave the volume of the brilliant portion. Stearine and paraffin candles of various thicknesses, and provided with different wicks, were compared by means of a rod photometer. It was soon found that the height of the flame was not the only factor determining the brightness. A stearine candle of 5·88 cm. circumference had, on the other hand, a higher luminosity than another 6·49 cm. in circumference. But a determination of the ratio of the volume to the illuminating power showed that this ratio is very nearly constant, the difference between the actual luminosity and that calculated from its volume never exceeding 3 per cent. In other words, equal volumes of the bright flame of any two candles give out the same amount of light.

AT a recent meeting of the Société Française de Physique, Dr. d'Arsonval exhibited a new form of electrical machine which has been devised by M. Bonetti. The machine is a modification of the ordinary Wimshurst pattern, the improvements introduced by M. Bonetti consisting in the suppression of the metallic sectors and the replacement of the single brushes at the extremities of the transverse conductor by three at either end. As a result of these changes, the output of the machine, and the length of spark it is capable of giving, are both increased. If two similar machines are taken, one having metallic sectors and the other without, and the output is measured with a Lane's jar, it is found that the machine without sectors gives an output from two to four times as great as the ordinary form. Another advantage possessed by the new form of machine is that it is not subject to a change in polarity while at work. Although the machine is not self-exciting, it can be started by placing the finger against the upper part of one of the rotating discs while it is in movement. If it is desired to change the polarity of the machine, it is only necessary to place the finger at the same part of the opposite disc.

IN a second paper, on the polarisation upon a thin metal partition in a voltameter (*Philosophical Magazine*, March 1894), Mr. John Daniel discusses the passage of ions through a gold-leaf partition, and also the minimum current-strength at which the ions are deposited visibly upon the partition for various electrolytes. In order to investigate the first point two similar voltameters with metallic partitions were set up at the same time, and, without passing the current quantitative analyses of the solution on the two sides of the partition, were made at stated intervals; then the current was passed, the voltameters being in series, quantitative analyses being again made of the solution on the kathode side, and the weight of copper deposited on the kathode determined, and finally the circuit was broken and the analyses again repeated. Curves plotted from these results show

no break nor change of slope for the intervals during which the current was passing. Thus it would appear that the current does not sensibly affect the diffusion of copper sulphate and sulphuric acid through a gold-leaf partition. In the experiments on the "critical current" it was found that the concentration of the electrolyte exerted an important influence on the value obtained, and the measurements made indicate that the "critical current" is proportinal to the conductivity of the electrolyte. Experiments made to determine whether the variation of the temperature has the same effect upon the "critical current" as upon the conductivity, are not yet sufficiently complete to justify conclusions being drawn.

MR. HENRY GANNETT, of the United States Geological Survey, has published the results of his calculation of the average elevation of the United States with a magnificently-coloured contour-map of the whole area on the scale of about 100 miles to an inch. The contouring is in large part hypothetical, but the discussion takes all considerations into account in order to present the results as accurately as possible. It is estimated that the mean elevation of the United States is 2500 feet, a little greater than Dr. Murray's estimate of the mean elevation of the land of the globe. Delaware is the lowest State, averaging only 60 feet above sea-level, while Wyoming and Colorado are the highest, respectively 6700 and 6800 feet. Eleven States are above the average level, all being on the Pacific coast or in the adjacent Cordillera region. Florida and Louisiana are the least elevated States next to Delaware, being only 100 feet in average height. In making these calculations the levels of railway lines were extensively utilised to supplement the somewhat scanty determinations of altitude made by official surveyors.

THE few regions of Europe still unexplored formed the subject of consideration at the last meeting of the Royal Geographical Society, when Mr. W. H. Cozens-Hardy described his recent journey through Montenegro and the borders of the adjacent Turkish provinces of Albania and Novi-Bazar. Mr. Cozens-Hardy has been able for the first time to map accurately the frontiers of Montenegro as defined by the Treaty of Berlin, and he succeeded in gaining the good-will of the people, penetrating for some distance into Albania, where the practically independent tribes still make travelling dangerous. The northern and eastern parts of Montenegro consist of grassy mountains, forests, and fertile valleys, contrasting with the bare rocky hills and river-basins of the coast region and the centre.

THREE Norwegian whalers have attempted seal fishery in the Antarctic waters south of the Falkland Islands during the southern summer now ending. One of these vessels was as far south as 69° or 70° without finding enough ice to make sealing profitable, and it is reported that a considerable extent of new land has been discovered and charted.

THE botanical collections made by Messrs. Burk and W. E. Meehan during the Peary expedition, are described in the *Proceedings* of the Philadelphia Academy, under the title "Contribution to the Flora of Greenland." One hundred species of flowering plants and vascular cryptogams are enumerated, thirty-nine of lichens, and twenty-eight of mosses.

HERR S. CSAPODI records in the *Sitzungsberichte* of the *Ungarische naturwissenschaftliche Gesellschaft von Budapest*, the curious fact that several mould-fungi, especially *Mucor Mucedo*, will grow on solid compounds of arsenic, giving off arsenical vapours. This may be compared with Zukal's observation of the growth of *Halobyssus moniliformis* in a saturated solution of sodium chloride, and the existence of living fungi in solutions of salts of copper.

SIR DOUGLAS GALTON calls attention to an important and extensive investigation being carried out by the committee on the mental and physical condition of children, of which he is the chairman. About 50,000 school children have been seen individually, and from the notes taken it appears that about seven per cent. were mentally dull, and that sixteen per 1000 require special care and training. It is proposed to report upon 100,000 children if the necessary funds are forthcoming, and for this an appeal is made to all who, while desiring progressive education, also desire that the training of children should be conducive to the development of both sound bodies and brains.

MR. C. A. BARBER, Superintendent of Agriculture for the Leeward Islands, contributes to the *Leeward Islands Gazette* a report on the diseases of the sugar-cane in the West Indies. It refers chiefly to the insects which attack the canes, the various stages of the different species being described and figured. The *Kew Bulletin* for March contains also a correspondence on the subject between the Director of the Gardens and the Director of Forests and Gardens for Mauritius. This refers to the destruction of the crop by the parasitic fungus *Trichosphæria Sacchari*, which has apparently been introduced into Mauritius from the West Indies.

THE *Journal* of the Royal Asiatic Society of Bengal for November 27, 1893, contains an interesting article on the "Blind Root-suckers of the Sunderbans," a tract of swampy littoral forest occupying the southern portion of the Delta of the Ganges. A large number of the trees which inhabit this area are furnished with root-suckers in the form of woody processes growing in an upward direction, and developed at irregular distances along the whole course of the roots. They project from one to three feet above the surface of the ground, and apparently cease to grow when the apex has reached the level of the highest spring-tides. The main object of these structures is to protect the tree against the uprooting effect of violent winds in the swampy soil; but they also contain a system of air-chambers for the aeration of the root. They never produce buds.

READERS of Hermann Müller's "Die Befruchtung der Blumen," or its excellent translation by Prof. D'Arcy Thompson, will remember its opening sentence: "It was not until the close of the last century that the true purport and significance of flowers began to be perceived. Christian Conrad Sprengel seems to have been the first to view the subject in the light of adaptation, and to show how all the colours, scents, and singular forms of flowers have some useful purpose. His book struck out a new path in botanical science, and its title, 'The Secret of Nature revealed in the Formation and Fertilisation of Flowers,' shows that the author was well aware of the importance of his discoveries." This work of Sprengel's, "Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen," was published in Berlin in 1793, and for many years has been an exceedingly rare and costly book. In spite of the teleological standpoint of all Sprengel's researches, it will always be a book of interest and of reference; we are therefore glad that advantage has been taken of the centenary of its appearance, to bring out a facsimile reprint, which has just been published as one of Mayer and Müller's "Wissenschaftliche Classiker in Facsimile-Drucken." The volume contains 224 quarto pages and twenty-five plates, and costs only eight marks.

IN a paper, "Influenza della luce solari sulle acque di rifiuto," Dr. Procacci contributes to the *Annali dell' Istituto d'Igiene Sperimentale di Roma*, vol. iii. p. 437, the results of his numerous investigations on the bactericidal action of sunshine on the microbes normally present in drain-water.

Cylindrical glass vessels about 60 c.m. high and 25 c.m. wide were employed; from some of these the light was excluded, whilst in others it was allowed free access. The temperature of the latter never exceeded that of the former by more than from 2°–4° C., and in neither case did it ever extend beyond from 40°–42° C. In every instance a marked diminution in the bacterial contents was observed in the insolated vessels, whilst at the same time a more or less marked increase took place in those protected from the sunshine; the period of exposure varied from one and a half to nine hours. Of particular interest are the investigations made to ascertain to what depth in the water the antiseptic action of the sun's rays extended. It appears that when the vessels were exposed to the perpendicular as well as the oblique rays of the sun, the bactericidal power of insolation was unimpaired at the bottom of the vessel, a depth of half a metre; but when the perpendicular rays only were admitted, no diminution took place in the number of bacteria present at this distance from the surface. That the oblique rays rendered important service in the destruction of the micro-organisms was further shown by a special bacterial examination of portions of the liquid in the immediate vicinity of the sides of the cylinder, for when the latter was freely exposed to sunshine, the smallest number of microbes was found in those parts of the liquid which were nearest to the walls of the vessel. Dr. Procacci, in summarising his results, expresses his belief that the bacterial purification which takes place during a river's course may in many cases, where the rate of flow is presumably too great to admit of sedimentation taking place, be attributed directly to the destructive action of sunshine on the suspended microbes.

THE *Psychological Review* for March contains several important papers, among them being one on reaction-times and the velocity of the nervous impulse, by Profs. C. S. Dolley and J. McKeen Cattell. The object of the authors' investigations was to determine the conditions which affect the length of reaction-times on dermal stimuli, and to study the application of the reaction-time to the measurement of the velocity of the nervous impulse in motor and sensory nerves, and in the motor and sensory nerves of the spinal cord. For the application of the stimuli, two points were chosen on the arm over the median nerve, and two on the leg over the posterior tibial nerve. The points on the arm were 30 cm. apart, and those on the leg 50 cm. apart, and the length of intervening nerve would be nearly the same. It was found that the reaction-times were longer when the stimulus was applied to the lower points on the arm and leg than when the points less distant from the brain were used. If the difference of time is really due to the difference in length of the nerve traversed, the velocity of the impulse in the sensory nerve is 21·1 metres and 49·5 metres per second, respectively, for the two observers. The velocity in the sensory fibres of the posterior tibial nerves was 31·1 metres per second for Prof. Dolley, and 64·9 metres per second for Prof. Cattell. This large difference between the two observers, however, is attributed to differences in the cerebral processes rather than to differences in the velocity of the impulse in the sensory nerve. In the case of reaction experiments with dermal stimuli the electric shock was mostly used, but as the physiological effects of the shock were found to vary greatly on different parts of the body, a method was devised for applying a touch or a blow. It was found that the same objective force of blow was followed by the same subjective sensation more nearly than in the case of electrical stimulation. From the difference in the reactions on touch when the stimulus was applied to the arm and to the thigh, the velocity of the nervous impulse in the sensory tracts of the spinal cord was determined as about 40 metres per second.

MESSRS. R. FRIEDLÄNDER AND SON, of Berlin, have sent us a set of their "Naturæ Novitates," issued during the last four months. The circulars contain lists of current scientific literature, the works being classified according to subjects.

THE Director of the Botanical Survey of India has published two valuable additions to our knowledge of the flora of British India: a report on a botanical tour in Kashmir, by Mr. J. F. Duthie, and a report on a botanical tour in Sikkim, by Mr. G. A. Gammie.

WE have received a fresh instalment (Band 3, 2te Hälfte, 2te Lieferung) of Cohn's *Kryptogamen Flora von Schlesien*, which includes the Tuberinei, Elaphomycetes, Saccharomycetes, and the commencement of the Pyrenomycetes. Two new genera and several new species are described.

A REPORT on North-Western Manitoba, and portions of the adjacent districts of Assiniboia and Saskatchewan, drawn up by Mr. J. B. Tyrrell, has been published by the Geological Survey of Canada. The report is accompanied by two maps, one showing the geology of the region, and the other the distribution and character of the forests.

IN the *Proceedings* of the Geologists' Association (vol. xiii. part 6) Mr. A. Smith Woodward briefly reviews the present state of knowledge of the sharks' teeth met with in British Cretaceous formations. The review is illustrated by two admirable plates, which will be of use to collectors; and several of the specimens described add something of importance to the facts previously known.

MM. RICHE AND ROUME contribute to the *Annales des Mines* (sér. 9, tome v., Liv. 1, 1894) a general account of the petroleum industry of the United States, the result of a visit to the districts made by the authors in 1892. The article deals in great part with the methods of refining, comparing them with processes used in France; but it also contains descriptions of the production areas in the Eastern States, and gives an interesting map of Pennsylvania showing the gas and oil districts.

MESSRS. SWAN SONNENSCHEIN AND CO. will shortly publish a new book by Mr. J. W. Tutt, under the title of "Woodside, Burnside, Hillside and Marsh." This will consist of a series of illustrated literary sketches, on somewhat similar lines to the author's "Random Recollections of Woodland, Fen and Hill," and will describe a series of natural history rambles in various parts of Kent and the Scotch Highlands, dealing with various branches of natural science in a popular way.

THE fourteenth volume of the Index-Catalogue of the Library of the Surgeon-General's Office, U.S. Army, has been issued. The volume comprises words between "sutures" and "universally." It includes 10,124 titles, representing 6426 volumes and 8850 pamphlets. In addition to this bulk of matter, there are 9867 subject-titles of separate books and pamphlets, and 38,461 titles of articles in periodicals. When the catalogue is completed, it will literally represent a solid monument to industry.

THE first of a series of monthly guides to the beauties of animate nature has been published by Messrs. Bliss, Sands, and Foster, under the title "The Country, Month by Month." Mr. J. A. Owen and Prof. G. S. Boulger are the authors of this little book, which will be followed by others, each devoted to a particular month of the year. The descriptions are interesting and brightly written, and dwellers in towns who read them will assuredly be tempted "to put forth and brave the blast" of this blustering month of March in order to see the woodlands returning to life.

WE have on several occasions referred to the interesting series of reprints being published by W. Engelmann, Leipzig. One

of the latest additions to the series is "Electrochemische Untersuchungen," edited by Prof. Ostwald, and containing Sir Humphrey Davy's Bakerian Lectures of 1806 and 1807, dealing with chemical changes produced by electricity (*Philosophical Transactions*, 1807 and 1808). Another reprint just received is Brücke's observations on the colour-changes of chameleons, originally published in 1852 under the title "Untersuchungen über den Farbenwechsel des Afrikanischen Chamäleons." The editor of this reprint is Dr. M. v. Frey.

WHAT is written by Dr. Paul Carus in a "Primer of Philosophy," published by the Open Court Publishing Co., Chicago, is written clearly. The book does not set out the ideas of any particular school of recent thought, but is rather "a critical reconciliation of rival philosophies of the type of Kantian apriorism and John Stuart Mill's empiricism." At the present time the man of science frequently ignores philosophy, and the cause of true science is injured thereby. Dr. Carus shows, however, that as all the sciences are inseparable from each other, so philosophy is inseparable from the sciences. When this truism is more widely recognised, a new vista will be opened to us, in which the old and the new scientific methods will be happily combined.

WE have received a copy of the official organ of the National Department of Hygiene in the Argentine, which is published weekly at Buenos Ayres, under the direction of the President of the Department, Dr. José M. Ramos Mejia. Besides containing original memoirs, it is intended to give, in a concise and handy form, abstracts and reviews of the more important papers on subjects connected with hygienic science which have appeared in foreign journals. We find in the present number an account of work recently published in the *Deutsche Medicinal Zeitung*, the *Therapeutic Gazette* (Philadelphia), the *Zeitschrift für Hygiene*, the *Revue Internationale de Bibliographie Médicale* (Paris), &c. The abstracts are not bare outlines, but are very full, containing elaborate tables and many details of the experiments described.

THE maps and plans illustrating the Report of the Royal Commission on Metropolitan Water Supply have now been issued. Of most general interest are a contoured map of the Thames Basin, and a geological map of the same area, reduced from the Geological Survey map. Both sheets are on the scale of four miles to one inch; the latter is illustrated by three geological sections. Diagrams are given of the flow of the Thames and Lea; rainfall and percolation at Lea Bridge; gaugings of the Chadwell Spring; quantity of water purified from the wells of the New River Company. There is also a map of Hertfordshire illustrating Mr. R. S. Middleton's special report to the Commission, which shows the underground water-contours, and a map by Mr. G. J. Symons showing the rainfall in the basins of the Thames and Lea. There are in all fourteen plates.

COLLECTIONS of aphorisms do not appeal very favourably to us, for the reason that they are apt to create a "conceit of knowledge." The tendency of to-day is to be content with bits of information on diverse subjects, and to eschew the steady reading necessary for a clear understanding of anything. A further objection is that it is extremely difficult to select extracts which give a true impression of the author's meaning. This has been done, however, by Miss J. R. Gingell, in "Aphorisms from the Writings of Mr. Herbert Spencer," published by Messrs. Chapman and Hall. The selections deal with education, evolution, science, sociology, politics, justice, liberty, truth and honesty, sympathy, happiness, self-control, &c. They are well arranged and to the point, and illustrate the scope of the synthetic philosophy. Miss Gingell's volume may therefore serve a useful purpose by presenting in a handy form Mr. Spencer's views on many subjects.

MR. J. E. WALKER defines his "Voices of the Stars" (Elliot Stock) as "a book of scientific facts and of mystical correspondences between the natural and the supernatural." Just as in early records we find that many peoples have endeavoured to accommodate natural phenomena to the prevailing type of religion, so Mr. Walker finds that the facts of astronomy suggest spiritual similarities. His book is very largely made up of extracts from the works of various astronomers, all the sources of information being acknowledged in foot-notes. The compilation shows clearly that the author is in touch with recent advances, and is capable of properly estimating the weights of the words and works of different observers. We cannot enter much into his spiritual interpretations of astronomical marvels, though the book abounds with such comparisons of the material and immaterial. To our mind, however, the analogues are frequently far-fetched and never impressive. By all means let life be put into what are often regarded as the dry bones of science; but it may be doubted whether dogma is able to assist in the resuscitation.

THE observations made at the Blue Hill Meteorological Observatory, Mass., in the year 1892, have recently been published as vol. xl. part ii. of the *Annals* of the Astronomical Observatory of Harvard College. There is an appendix giving particulars of experiments on atmospheric electricity. The volume concludes with an article on sudden changes of atmospheric temperature, in which it is suggested that there is a meteorological period as well as a magnetic one corresponding to the period of the sun's rotation.

A USEFUL contribution to our knowledge of the tropical hurricanes of the South Sea, between Australia and the Paumotu Islands, appears in *Aus dem Archiv. der Deutschen Seewarte* for 1893, by E. Knipping, formerly Director of the Meteorological Observatory at Tokio, Japan. It contains a list and short description of all storms observed since 1789, with references to the sources whence the information has been obtained, and the frequency of the hurricanes and their paths are plotted in five-degree squares. Of 125 hurricanes on which the discussion is based, 109 occur between December and March, 12 in April and November, and 4 in September, October, and May. Near the Fiji Islands the number of storms increases regularly from December to March, but near New Caledonia and the Samoa Islands the majority occur in January. The prevalent direction of their course is south-easterly, while others take a southerly and south-westerly direction. Some useful hints are also given as to the courses to be steered by vessels overtaken by the hurricanes.

DR. ALFRED KOCH'S *Yahresbericht über die Fortschritte in der Lehre von den Gährungs-Organismen* for 1892 has just been published. This is the third year of its issue, and affords an invaluable volume not only for purposes of reference for those engaged upon the original work on, but also for those interested in the history and literature of, the important subject of fermentation. Under the respective headings of i. Lehrbücher, Zusammenfassende Darstellungen, &c.; ii. Arbeitsverfahren, Apparate, &c.; iii. Morphologie der Bakterien und Hefen; iv. Allgemeine Physiologie der Bakterien und Hefen; v. Gährungen in Besonderen; vi. Fermente—are to be found notices of, and excellent abstracts of the more important original memoirs published during the year. It is, in fact, a record of scientific progress, not only in the department of fermentation, but also in other branches of bacteriology more or less closely connected with it. The work is admirably done, and it is to be hoped that Dr. Alfred Koch will find sufficient support to ensure

its continuation for many years to come. We would, however, suggest that its value for purposes of immediate reference would be greatly enhanced by its publication being more prompt.

THE additions to the Zoological Society's Gardens during the past week include a Wild Cat (*Felis catus*) from Inverness-shire, presented by Mrs. Ellice; a Solitary Thrush (*Monticola cyanus*) European, presented by Mr. J. Young; a Diana Monkey (*Cercopithecus diana*, var. *ignitus*, ♀) from West Africa, deposited; three Alpine Accentors (*Accentor collaris*), a Bluethroat (*Cyanecula suecica*) European, purchased.

OUR ASTRONOMICAL COLUMN.

A NEW ACHROMATIC OBJECT-GLASS.—It is well known that in consequence of the irrationality of dispersion the nominally achromatic object-glass is really very far from achromatic. There is always a residual colour, frequently called the secondary spectrum, so that the images of bright stars are surrounded by halos of blue and red light. For this reason a refracting telescope designed for visual observations cannot be employed for photography. Many attempts have been made to correct this colour aberration of the achromatic lens, but the plans hitherto suggested have never been practically adopted, owing to difficulties of construction, or to the imperfect durability of the glasses employed. Mr. H. D. Taylor, optical manager to Messrs. T. Cooke and Sons, has recently taken up the question, and he appears to have come very near to a practical solution of the problem. He has aimed at producing an objective which shall be (1) almost perfectly achromatic; (2) equally well corrected for photographic purposes as for visual purposes; (3) capable of practical construction in large sizes; and (4) of ordinary durability.

The new object-glass which is to satisfy these conditions is a combination of two positive lenses and one negative lens, each made of a kind of glass possessing different optical properties. The necessary glasses are manufactured by Messrs. Schott and Gen, of Jena, and there is no reason to believe that there will be any difficulty in the production of large discs. The separate lenses are so constructed that the partial dispersions of two of the lenses combined are as nearly as possible equal to those of the third lens when acting singly. It is calculated that with the kinds of glass actually available the greatest departure from focus in the case of a 12-inch object-glass of 15 feet focus would be about 0·06 inches for the H rays, or only $\frac{1}{15}$ that in an ordinary object-glass of similar dimensions. The curvatures of the lenses are designed to minimise the difficulty of practical construction and testing, and no important loss of light is anticipated from the increased thickness of glass which the new object-glass requires. Indeed, it is probable that there will be a considerable gain of light-gathering power from the convergence of all the luminous rays to a common focus. (Full particulars are given in the Patent Specification, No. 17,994, 1892.)

SOLAR MAGNETIC INFLUENCES ON METEOROLOGY.—Under this title Prof. H. A. Hazen has published a pamphlet dealing with the supposed existence of electric or magnetic fields in the atmosphere, and the possibility of their accounting for weather phenomena. The subject has for some time been under investigation by Prof. F. H. Bigelow, and papers upon it have been published by the United States Weather Bureau, and in several American journals. Prof. Bigelow considers that under certain conditions of the sun there would be generated two distinct magnetic fields—one from the photosphere, and one from the nucleus, the earth being traversed by at least three fields of magnetic force: the lines of permanent magnetism, those from the electro-magnetic or radiant field, and those from the magnetic or coronal field. The radiant field would be favourable to producing warm, dry, high-pressure areas, as seen in the tropical belt, while the magnetic polar field would be favourable to the production of cold, dry, high-pressure areas, such as frequent the storm-belts farther north. It is with the latter influence that we have chiefly to do, in which Prof. Bigelow detected systematic changes recurring in about twenty-seven days. On projecting temperature curves for different parts, according to this magnetic ephemeris, he found *inter alia* that there is a continual lag in the time at which the maximum and minimum points of the curve reach the stations lying to the eastward, *e.g.* a minimum point in the curve in the eastern part of the country corresponds to a maximum point in the west, and *vice versâ*. Prof. Hazen puts these theories to various tests, amongst them the passage of hot and cold waves across the United States, and he concludes that the outcome of these investigations must be a "bitter disappointment" to those who believe in an all-important influence, aside from heat, from the sun upon our weather changes. He admits that there is undoubted evidence that some influence does exist, but at present it appears to be masked by terrestrial conditions, which have yet to be studied and eliminated.

A NEW TELESCOPE FOR GREENWICH.—The *Observatory* announces that Sir Henry Thompson has offered the magnificent sum of £5000 to the nation, through the Astronomer Royal, for the purpose of buying a telescope for Greenwich Observatory. The instrument is to be expressly designed for photographic purposes, and, subject to the acceptance of the offer by the Government, will have an aperture of 26 inches. It will be made from the model of the equatorials used for the photographic chart of the heavens, but with double the dimensions of those telescopes. The guiding telescope will be the 12¾-inch Merz refractor, with a light tube. It is intended to house the new instrument under the Lassell Dome, on the top of the central octagon of the new Physical Observatory, now being built in the south grounds of the Royal Observatory.

OCCULTATION OF SPICA.—On the morning of Good Friday the bright star Spica will be occultated by the moon. At Greenwich the disappearance takes place at 4.5 a.m. at the position angle 123°, and the star will reappear at 5.13 a.m. at position angle 297°, the angles being read from north in the direction north, east, south, west. The occultation will be visible at places between latitudes 79° north and 16° north, which are not too far from the meridian of Greenwich. The moon will be a little past full at the time.

NEW NEBULÆ.—Dr. Max Wolf announces in *Astr. Nach.* 3214, that several new nebulous patches appear upon photographs of the regions round β and δ Cassiopeiæ, taken at the end of last year and the beginning of this, with exposures of about sixteen hours. Three of these spots have the following positions:

	h. m.		° ′
R.A.	... 0 49 0	Decl.	... 60·20
,,	... 0 51·9	,,	... 60·5
,,	... 1 38·0	,,	... 59·5

THE MINUTE STRUCTURE OF THE NERVE CENTRES.

THE Croonian Lecture was delivered by Prof. Ramon y Cajal at the Royal Society on March 8. After giving a short historical survey of his subject and referring to the work of Kölliker, His, Van Gehuchten, Waldeyer, Edinger, Von Lenhossék, A. Sala, P. Ramon, and Retzius, Prof. Cajal proceeded to give an account of his own work, and pointed out in what particulars his results differed from those of Camilo Golgi, the originator of the silver impregnation method. Golgi had shown that the protoplasmic expansions of nerve cells terminate by free extremities in the grey matter, that the prolongations of the nerve cells give off in their course through the grey matter very fine ramifying collateral branches, and that two types of cells may be distinguished—a motor type, distinguished by an unbranched axis cylinder, which becomes continuous with a fibre in the white matter, and a sensory type, distinguished by possessing an axis cylinder which on leaving the cell divides so freely that its individuality is lost as it ramifies in the grey matter. Within the grey substance a network of fibres is formed by the terminal twigs of centripetal nerve fibres, ramifications from the network derived from sensory cells, and collaterals of protoplasmic processes of motor cells.

Passing on to the results of his own work, Prof. Cajal showed that axis cylinders, in addition to the protoplasmic prolongations, end by free terminations in the grey substance. He does not admit that there is any sharp functional difference between the

motor and sensory cells, since morphologically motor cells are found in the olfactory bulb and the retina, and Golgi's sensory cells are sparsely found in the same regions, and, consequently, it is impossible to deduce the function of a cell from its shape and mode of branching.

The connection of the axis cylinder with the sensory cells of the grey matter is not by the mediation of a network, but by free arborisations around cells.

In birds and mammals the cells in the root ganglia have an axis cylinder which extends from the periphery, and the internal branch, entering the cord by the posterior root, bifurcates in the white matter. An ascending branch can be traced for several centimetres along the posterior column, and is found to end by arborisations around cells in the grey matter. The descending branch has a similar distribution. All branches, however, do not bifurcate. Collateral branches, long and short, pass off in bundles at right angles from the main branch and its bifurcations; the destiny of the short collaterals is the grey matter where their varicose arborisations surround the cells in the head of the posterior horn and the cells of Clarke's column. The long collaterals pass in a bundle from the ascending or descending branches and ramify in the substance of the anterior horn, where they come in contact with the bodies or the protoplasmic prolongations of motor cells. From this distribution it is obvious that the extremity of the long collateral is in contact with the body or the protoplasmic processes of the motor cell. For this reason Prof. Cajal speaks of the long collaterals as "*sensitivo-motor*," though Kölliker's term "*reflexo-motor*" enables the physiology of these to be the more easily grasped.

The grey matter of the cord contains at least four types of cells—the *commissural*, where the axis cylinder of the cell is in connection with the opposite antero-lateral column by way of the anterior commissure, cells in connection with the antero-lateral and posterior columns of the same side, motor cells in connection with the anterior root and "*pluricordonal*" cells, where a complex axis cylinder furnishes two, three, or more medullated fibres in connection with the columns of one side or of both.

Cajal holds that, according to the strength of the excitation, impulses entering by the posterior root may pass by the long collateral to the motor cells, and the expression of this is a reflex, or where the excitation is stronger, besides this route, the short collaterals as well as the ascending and descending branches of the bifurcated sensory fibres may conduct, in consequence of which other cells are thrown into activity.

Cajal considers the retina as a nerve ganglion formed of three tiers of neurones, the first of which includes the rods and cones, together with their processes as far as the external granular layer; the second composed of the bipolar cells, and the third of the ganglionic cells.

The internal and external molecular layers are the regions where the connections of the neurones are established. The excitatory process, started in the rods and cones, passes along the bipolar cells, the ganglion cells, the fibres of the optic nerve, into the fusiform and pyramidal cells of the geniculate body and the corpus quadrigeminum.

The optic nerve contains also centrifugal fibres which terminate by varicose arborisations around the spongioblasts of the retina, to which they carry impulses started by nervous excitations of central origin, the significance of which is obscure.

In the cerebellum a transverse section shows three concentric layers of neurones; the first, or molecular layer, consists of small stellate cells, the second of the cells of Purkinje, and the third of the granular layer. All these elements have connections of two kinds—intrinsic, which place the cells of the three layers in connection with each other, and extrinsic between the cerebellar neurones and the neurones of other nervous organs.

The connections of the granules, which are nervous organs, with the cells of Purkinje, are of great interest. The former possess three or four very short protoplasmic processes, each of which breaks up into an arborisation. An axis cylinder of exceeding fineness passes up to the molecular zone, bifurcating at various levels. During their course they come into intimate contact with the protoplasmic processes of the cells of Purkinje. Since each of these parallel fibres traverses the total thickness of the grey matter of a cerebellar convolution and ends by free extremities at the surface, it follows that a single granule is able to act on a multitude of cells of Purkinje. Each of these last is under the influence of a considerable number of granules.

The extrinsic relations (those between the cells of the cerebellum and those of other nervous centres) are very difficult to establish.

As Golgi first showed, the cells of Purkinje give rise to nervous prolongations of the long type of which the termination is unknown, and, on the other hand, there end in the grey matter of the cerebellum axis cylinders coming from other organs, of which the situation is very uncertain. These are the *fibres moussues* and the *fibres grimpantes*. The *fibres moussues* terminate in the molecular layer by collateral processes which are in contact with the protoplasmic expansion of the granules. The ultimate twigs terminate in a varicosity, or in a small ramification. The *fibres grimpantes* traverse the granular layer, coursing along the cells of Purkinje, and surrounding the ascending stem and the proplasmic branches with an elongated terminal arborisation quite comparable with that of a motor fibre in muscle.

It appears therefore that the cells of Purkinje may receive nervous impulses from other centres, either by means of the *fibres moussues*, or by means of the *fibres grimpantes;* whilst the small stellate cells of the molecular layer, as well as the large stellate elements of the granular layer belong to the second type of Golgi's cells, appearing to have no relations with the extrinsic fibres. These last cells are therefore styled "*association corpuscles*," as they appear to have for their exclusive rôle the association of the cells of Purkinje, or the granules, into a dynamic whole of which the significance is unknown.

In the cerebral cortex, for the sake of clearness, three main layers may be distinguished, a molecular layer, a layer of large and small pyramidal cells, and a layer of cells of various shapes. The molecular layer, which is always found in the brains of vertebrates, is formed of a very complicated plexus, the principal factors of which are the peripheral ramifications of the pyramidal cells, the terminal nervous arborisations of certain cells of the pyramidal layer of which the axis cylinders are ascending, and the ramifications of certain cells of fusiform or triangular shape, the greater part of whose expansions become horizontal, and resolve themselves into a large number of twigs. One may compare these elements with the spongioblasts of the retina and with the granules of the olfactory bulbs, as they also are without a differentiation into protoplasmic and nervous expansions.

The layer of pyramidal cells, the thickest layer of the cortex, consists of many elongated cells of pyramidal form, the principal characteristic of which is the possession of a protoplasmic stem, terminating in the molecular layer as a more or less horizontal arborisation of fibres, covered with spiny processes, and giving off many lateral and descending protoplasmic branches, and finally giving rise to a descending axis-cylinder continued to the white substance. The last layer consists of cells of variable form, usually elongated, one of the prolongations very often going towards the surface. The axis cylinder penetrates the white substance, and resembles that of the pyramidal cell.

In their passage through the grey matter all the axis cylinders of the pyramidal cells and the cells of variable shape give off a large number of ramifying collaterals, which terminate freely around the nerve cells. The whole of the ramifying collaterals form in the grey substance, and around the cells, a plexus of extreme complexity, in which are also present ramifying collateral twigs from the white substance and terminal arborisations of fibres of association.

The connections of the pyramidal cells of the cortex may be distinguished as *superficial* (belonging to the molecular layer) and *deep* (belonging to the subjacent layers).

In the molecular layer each protoplasmic "plume" of the pyramidal cells is in contact with an almost infinite number of terminal nervous fibrillæ derived from the terminal arborisations of fibres of association originating in cells in the hemisphere of the same or of the opposite side; from special cells in the subjacent layers; from special cells in the molecular layer itself; from collateral fibres from the white substance, or from the deep layers of the grey substance, and from other situations.

In the molecular layer, then, each pyramidal cell may be influenced not only by the cells of the same region of the cortex, but also by others which lie in other lobes, it may be of the same side or of the opposite side of the brain. It is also probable that the molecular layer receives the ultimate ramifications of

the sensory nerves. Thus the peripheral "plume" of the pyramidal cells would be the spot at which the voluntary motor impulse arises, to be communicated to the body of the pyramidal cell, and so to the fibres forming the pyramidal tract.

When an electrical stimulus is applied to the cortex, muscular movements are produced, because the stimulus acts either upon the "plumes" or upon the nervous fibrils whose function it is to carry impulses to the "plumes." Every nerve centre is made up of four constituents: nerve cells with short axis cylinders, terminal nerve fibres coming from other centres or from distant parts of the same centre, nerve cells with long axis cylinders, and collaterals which arise from axis cylinder prolongations of cells, or from nerve fibres of the whole substance. In the retina, olfactory bulb, and molecular layer of the cerebrum, there are in addition cells characterised by the absence of differentiation of nervous and protoplasmic expansions.

In organs where it is well established that excitatory processes arise the cells are polarised, *i.e.*, the nervous impulse always enters by way of the protoplasmic apparatus, or by the body of the cell, and leaves by the axis cylinder, which transmits it to a new protoplasmic apparatus. The differentiation of the protoplasmic apparatus is for the purpose of enabling each cell to be connected with different kinds of nerve fibres, and the more varied the protoplasmic expansion, the greater the number of cells under whose influence it comes. In the same way the more the nervous expansion of a cell is extended, and the more collaterals it possesses, the greater is the number of cells to which its impulses may pass.

In the pyramidal cell of the brain of mammals, the differentiation and extension of the protoplasmic expansion, and the multiplication of the collateral and terminal nervous twigs are carried to their highest point, and on descending the scale both the differentiation and the number of twigs becomes rapidly less; in fish the pyramidal cell is absent.

As regards the education of the brain mental activity is not able to improve the cerebral apparatus by augmenting the number of cells, as the nervous elements lose their power of dividing during the embryonic period, but it is probable that intellectual exercise may produce in certain regions of the brain a large development of the protoplasmic apparatus and of the system of nervous collaterals, so that the associations already existing between certain groups of nerve-cells would be perfected by a further development of terminal twigs, of protoplasmic endings, and of nervous collateral branches, whilst quite new intercellular connections might be established by a new formation of collaterals and protoplasmic expansions.

"Vis à vis de la théorie des réseaux celle des arborisations libres des expansions cellulaires susceptibles de s'accroître apparaît non seulement comme plus probable, mais aussi comme plus encourageante. Un réseau continu pré établi—sorte de grillage de fils télégraphiques où ne peuvent se créer ni de nouvelles stations ni de nouvelles lignes—est quelque chose de rigide, d'immuable, d'immodifiable, qui heurte le sentiment que nous avons tous que l'organe de la pensée est, dans certaines limites, malléable et susceptible de perfection, surtout durant l'époque de son développement, au moyen d'une gymnastique mentale bien dirigée. Si nous ne craignions pas d'abuser des comparaisons, nous défendrions notre conception en disant que l'écorce cérébrale est pareille à un jardin peuplé d'arbres innombrables, les cellules pyramidales, qui, grâce à une culture intelligente, peuvent multiplier leurs branches, enfoncer plus loin leurs racines, et produire des fleurs et des fruits chaque fois plus variés et exquis.

"Du reste nous sommes très loin de croire que l'hypothèse que nous venons d'esquisser puisse à elle seule expliquer les grandes différences quantitatives et qualitatives que présente le travail cérébral chez les divers animaux et dans la même espèce animale. La morphologie de la cellule pyramidale n'est qu'une des conditions anatomiques de la pensée. Or cette morphologie spéciale ne suffira jamais à nous expliquer les énormes différences qui existent au point de vue fonctionnel entre la cellule pyramidale d'un lapin et celle d'un homme, ainsi qu'entre la cellule pyramidale de l'écorce cérébrale et le corpuscle étoilé de la moelle ou du grande sympathique. Aussi à notre avis est-il très probable qu'en outre de la complexité de leurs rapports les cellules pyramidales possèdent encore une structure intraprotoplasmique toute spéciale, et même perfectionnée dans les intelligences d'élite, structure qui n'existerait pas dans les corpuscles de la moelle ou des ganglions."

ON THE IRRITABILITY OF PLANTS.[1]

SOME years ago I published my observations on the strange and till then undescribed effect produced by various bodies on the sporangiferous hyphæ of *Phycomyces nitens*, well known to every plant-physiologist. To be brief, the phenomenon consisted in the fact that certain bodies attract *Phycomyces*, *i.e.* these bodies cause the hyphæ growing in their vicinity, at a distance of from one to two centimetres, to make curves in their growth, the concavity of which is directed towards the said body. This was particularly the case with iron; zinc and aluminium exhibited the same phenomenon, though in a smaller degree (aluminium only so slightly, that I now feel inclined to count this body among the inactive ones), while other metals showed no effect. In many other bodies the same effect was observed. The sporangiferous hyphæ, on the other hand, have a repellent effect on each other. I formerly designated this phenomenon as dependent on "physiological action at a distance."

At the Edinburgh meeting of the British Association for the Advancement of Science, held in August, 1892, Prof. L. Errera, of Brussels, read a paper on this subject, which was published in the Report of the Society, p. 746, having appeared earlier in the "Annals of Botany" (vol. vi. No. 24, December, 1892). He considered the phenomenon to depend on a kind of hydrotropism.

It is a well known fact that the sporangiferous hyphæ are negatively hydrotropic, *i.e.* that they curve away from a surface which discharges aqueous vapour, and the reciprocal repulsion of the hyphæ was considered by Errera to be a case of negative hydrotropism. From this it was naturally concluded that they are, on the other hand, attracted by a body that absorbs water. The effect of iron, since iron does actually absorb water in a damp atmosphere, is set down by Errera as a confirmation of this supposition. Even in other bodies which absorb water, Errera was able to find the same effect of attraction; indeed, in one case the inflexion of the hyphæ led to the discovery of the hygroscopicity of certain bodies. Thus the phenomenon would be bereft of its mysterious character, and classified among the already known qualities of this plant.

According to my experience, however, the explanation of Errera is not sufficiently well based to be yet admitted.

If iron acts as a hygroscopic (*sit venia verbo*) body, we should expect the phenomenon to be very clearly observable in these bodies, which are known to be particularly hygroscopic; for instance, potash and calcium chloride. But if a stick of caustic potash is fixed in the usual way above the culture of *Phycomyces*, taking care that the fluid dripping from the stick does not fall on the hyphæ or on the substratum, but into a small glass tube closed at the bottom, no attraction will be observed. The stick of potash absorbs much water from the atmosphere, its upper layers actually deliquesce, but, neither in its vicinity nor at a distance, do the hyphæ undergo any regular deviation from their direction of growth. I have made this experiment several times, and always with the same negative result. It is the same with soda. With solid calcium chloride it is difficult to work, because it deliquesces too quickly. I therefore used a solution of calcium chloride (one part of salt to one and a half part of water), with which I soaked a dry cylinder of plaster. This solution slowly absorbed aqueous vapour from the air; the cylinder consequently acted as a hygroscopic body, but no attraction could be observed. In one experiment the increasing weight of the cylinder (length 50 mm., diameter 11 mm., weight 4·904 gr.) was observed during the experiment; it amounted in four hours to 0·262 gr., and even then the body was not yet saturated with aqueous vapour.

Dry plaster also actively absorbs water from the air. I took a slab, measuring 80 × 35 × 10 mm., and dried it at 100°; it weighed 23·077 gr. During an experiment of six hours this slab was without effect on the *Phycomyces*; but in that time it had condensed 1·665 gr. of water. Now we might suppose that in this case the slab, by absorbing so much water, very soon came into a state in which it caused, neither positively nor negatively, hydrotropical curvatures; that in fact it had absorbed too much water to effect attraction, and too little to cause repulsion. But in the following six hours it still increased 0·049 gr. in weight, without exercising even now the least effect on the fungi.

In comparison with this, a plate of iron absorbs very little water. Such a plate, the total surface of which was 4950 mm.,

[1] "Öfversigt af Finsk. Vet. Soc. Förhand." Häft xxxvi. 1894

and consequently correspondent to that of the above-mentioned cylinder of plaster, increased in weight, in an atmosphere saturated with aqueous vapour, by only 3·5 mgr. in twenty-four hours.

If we argue that the hygroscopicity is the cause of the curvatures, we might assume that *Phycomyces* is only affected by bodies which absorb very little water, and that the above-mentioned bodies, which are without effect on *Phycomyces*, are too strongly hygroscopic. But then a positive curvature ought to be seen, at a certain distance from the bodies, where the hygroscopic effect is weaker; and this is by no means the case.

With all these facts in view, I cannot agree with Errera's hypothesis that the attracting effect of iron depends on a kind of hydrotropism. According to the statement of Errera, many hygroscopic bodies attract the hyphæ, but it is hardly to be presumed that this is actually owing to hygroscopicity, as other hygroscopic bodies are without effect. It seems to me that this is a case of radiation, depending on the molecular state of the body, and manifesting itself by the physiological effect.

In one point Errera corrects my statements as to the effect of iron. I had found that the condition of the surface (burnished, roughly brightened, or somewhat rusty) did not affect the results. Errera says that the effect of burnished steel is very slight, and this I can confirm as regards very well burnished steel. In this circumstance Errera finds a confirmation of his hypothesis, since a burnished surface gets rusty, *i.e.* absorbs water very slowly. In my opinion this fact only implies that the state of the surface is of a certain importance for the radiation in question, as is known to be the case with regard to the radiation of heat and light.

It is self-evident that my idea of this phenomenon, as dependent on molecular vibration, is a mere hypothesis. It is, however, somewhat confirmed by the fact that similar physiological effects are produced by some phenomena, which we must, from the present stand-point of science, declare to be molecular vibrations; and the statement of this fact is the principal object of this paper.

Platinum belongs to the inactive metals, and well-burnished steel has, as mentioned above, a very slight effect. But if exposed for some time to direct sunlight, these bodies become active, *i.e.* the sunlight creates in them a condition which, though otherwise imperceptible, manifests itself by the fact that the body, clearly and even powerfully, attracts *Phycomyces*. The power of attraction appears on the illuminated as well as on the opposite side of the body. This condition of the body lasts for a few hours, but afterwards ceases.

This phenomenon is somewhat mysterious. It is indeed astonishing to see how the same piece of platinum-foil, which during a series of experiments was without effect on our *Phycomyces*, will attract them after being exposed to the sun, without undergoing any outward change.

But this phenomenon is not entirely without analogy. It is a well-known fact that a number of nonluminous bodies after being exposed to illumination emit light in a manner which has been described as phosphorescence. Some bodies phosphoresce only for fractions of a second, others for more than twenty-four hours. Metals do not belong to the phosphorescing bodies, but in the present case a kind of phosphoresence seems to take place which is not perceptible to our eyes, but, on the other hand, is effective on *Phycomyces*. The phenomenon might be designated as dark phosphorescence.

It is interesting to note that E. Becquerel, who thoroughly studied the phenomena of phosphorescence, had foreseen something of the kind. He says ("La lumière, ses causes et ses effets," 1867, i. p. 259): "Même si les corps ne sont pas lumineux dans le phosphoroscope, on ne peut dire qu'il n'existe aucun effet après l'action du rayonnement; car la lumière pourrait exciter des vibrations d'une autre vitesse que celles qui sont perceptibles à nos yeux (et en général plus lentes), et capables de donner lieu soit à des effets de chaleur, soit à d'autres actions moléculaires encore inconnues."

With regard to the requisite intensity of light, I need only state that in August intense sunlight during seventy minutes was sufficient to cause activity, whereas an exposition of five hours in cloudy weather was without effect. I have not found out the shortest effective period of the insolation; and as to the duration of the state induced by light, I can only say that bodies activated in the afternoon, which, on being tested at once, caused curvatures in three to four hours, were without effect the next morning.

That the effect is due to light, not to heat, is proved by experiments in which the steel and platinum plates were heated for hours to the temperature (40°–45°) indicated by the thermometers during the insolation.

That the ultra-violet rays of the sun have no particular share in the phenomenon, is proved by the fact that the light which has passed through a solution of quinine-sulphate activates the respective bodies.

In experimenting with other metals, and various non-phosphorescing bodies, I could not demonstrate with certainty any such activation by light, which fact, however, does not exclude the possible occurrence of a dark phosphorescence of too short a duration to cause a physiological reaction.

Finally, I have to mention that certain bodies are rendered active by heat. I have found zinc to be one of them. Having heated a stick of zinc (5 mm. in diameter) in a blow-pipe flame until it began to melt, and having then allowed it to cool down to the temperature of my hand, I got, after an experiment of a few hours, the most beautiful curvatures in *Phycomyces* I could wish for. After cooling down for several hours, the stick was no longer active in this manner. Here we can justly speak of positive thermotropism, which is all the more interesting, as Wortmann in his experiments (*Botanische Zeitung*, 1883, p. 462) found only negative thermotropism in *Phycomyces*.

Some other bodies are quite different from zinc. The same plate of platinum that was rendered active by an hour's insolation, remained, after being heated red-hot for five minutes, just as inactive as before. Also in copper, cobalt, nickel, tin, lead, and glass, no effect was to be produced by great heat. There is not the slightest doubt but that plants, in their thermotropic curvatures, are affected by vibrations issuing from the molecules of the body applied, and this is also very likely the case with regard to the effect of light. It therefore does not seem unjustifiable to assume that even molecular vibrations, which are inherent in the bodies themselves, or connected with some change that they undergo, may cause similar physiological effects.

FREDRIK ELFVING.

THE NEW IODINE BASES.

FURTHER details are given in the latest *Berichte*, by Prof. Victor Meyer and Dr. Hartmann, concerning their recently-discovered basic compounds of iodine. It will be remembered that the fundamental base from which these new substituted bases are derived is the hypothetical compound $HO.IH_2$, and that the derivative $HO.I\langle{C_6H_5 \atop C_6H_4I}$ had been isolated as a strongly alkaline substance readily soluble in water, and which forms salts with acids with elimination of water, exactly like ammonium hydroxide. For the parent substance, therefore, the name iodonium hydroxide is proposed. At the conclusion of their first paper, Prof. Meyer and Dr. Hartmann announced that they had just succeeded in isolating the simpler di-phenyl derivative $OH.I(C_6H_5)_2$, and the present communication describes the strange mode of its genesis, and the character of the free base and its salts. The beautifully crystalline iodide was frequently obtained in small quantities during the whole course of Prof. Meyer's work with iodoso-benzene. It was observed that methyl iodide acts with great energy at the ordinary temperature upon the latter compound, and the product yields in contact with moist silver oxide a liquid from which potassium iodide precipitates crystals of the new iodide, $I.I(C_6H_5)_2$. It was subsequently found that when iodoso-benzene itself is triturated with moist silver oxide, the filtered liquid likewise yields similar crystals of diphenyl-iodonium iodide upon the addition of potassium iodide. This discovery led to a systematic study of the conditions of the reaction, and it was eventually elicited that freshly-prepared iodoso-benzene is incapable of so acting, but that by a few days' exposure in a thin layer to daylight, or, better still, by heating for some hours to 60°, it is rendered capable of producing the new base when brought in contact with oxide of silver. Moreover, it was ascertained that potash or soda are likewise capable of bringing about the change, although owing to subsidiary decompositions, not so advantageously as moist oxide of silver. It has finally been proved that the reaction depends upon the fact that upon heating to 60° or exposure to sunlight iodoso-benzene, C_6H_5IO, is partially converted into the more highly oxidised compound $C_6H_5.IO_2$, and by the action of moist silver oxide upon the mixture of the two

diphenyl-iodonium hydroxide and silver iodate are produced, in accordance with the following equation :—

$$C_6H_5.IO + C_6H_5.IO_2 + AgOH = AgIO_3 + HO.I(C_6H_5)_2.$$

When a mixture of the two iodine aromatic derivatives, in the proportions required by the above equation, together with sufficient oxide of silver, is vigorously agitated for three hours in a triturating machine, such as that in use in the Heidelberg laboratory, and filtered, the clear solution upon the addition of potassium iodide solution yields over ninety per cent. of the calculated weight of crystals of diphenyl iodonium iodide. The iodic acid remains partly as silver salt in the residue, and partly as iodate of the new base in the solution.

The salts of the iodonium bases bear a remarkable resemblance to those of lead, silver, and in particular thallium. Those of the first discovered base were described last week, but those of the diphenyl base are still more interesting, and many of them crystallise well.

The iodide obtained as above described forms large and beautifully grouped acicular crystals which melt at 175°–176°. During the act of melting it passes completely into mono-iodo-benzene, of which it is a polymer :—

$$I.I(C_6H_5)_2 = 2C_6H_5I.$$

The chloride, $Cl.I(C_6H_5)_2$, is slowly precipitated upon the addition of a soluble chloride to the aqueous solution of the free base, in crystals which are very similar in aspect to those of lead chloride. From hot aqueous solutions excellent crystals separate upon cooling.

The bromide, $Br.I(C_6H_5)_2$, crystallises likewise from hot water, and the crystals are perfectly colourless, and frequently attain large size.

The aqueous solution of the free base, $HO.I(C_6H_5)_2$, is very stable ; it may be preserved unchanged for many days. Upon concentration of the strongly alkaline solution a thick syrup is eventually obtained of powerfully alkaline nature, but which has not yet been crystallised. It absorbs carbon dioxide with great avidity, forming a carbonate of the base, which effervesces upon the addition of a dilute acid ; the carbonate, indeed, very much resembles that of thallium, being soluble in water.

Strangest of all these reactions, perhaps, is the behaviour of the solution of the base towards soluble sulphides. Sodium sulphide precipitates a bright yellow sulphide of the base, closely resembling arsenious sulphide, while ammonium sulphide precipitates a beautiful deep orange-coloured polysulphide, identical in appearance with freshly precipitated antimonious sulphide. Both sulphide and polysulphide decompose after a time with separation of an oil, consisting in the former case of iodobenzene and phenyl sulphide, and in the latter case of the same substances together with other phenyl sulphides. The work is being continued, and Prof. Meyer hopes before long to have something further to communicate concerning this unexpected and exceptionally interesting class of compounds. A. E. TUTTON.

THE ETHNOGRAPHY OF THE ARAN ISLANDS, COUNTY GALWAY.

WHEN Professors Cunningham and Haddon opened their anthropometric laboratory in Dublin, rather more than two years ago, one of their objects was to promote systematic research in the country districts of Ireland. We have now received the first-fruits of the laboratory in the form of a paper on the ethnography of the Aran Islands, by Prof. A. C. Haddon and Dr. C. R. Browne, read before the Royal Irish Academy. The lines of research originally proposed have been considerably exceeded, and the paper before us is in reality a brief monograph of the islands. The observations, however, have been made chiefly on the inhabitants of Aranmore, the northern and largest of the three islands forming the group ; and the southern island, Inisheer, was not visited at all.

The inhabitants of Inisheer, and of the middle island (Inishmaan), have been less subject to foreign influence than Aranmore, but the proximity of Inisheer to the mainland having rendered intercourse with Ireland easy, appears to have given to the inhabitants of that island a somewhat distinctive character.

The number of individuals actually measured by the authors was twenty-seven, twenty of them being natives of Aranmore, and the other seven being Inishmaan men ; all were males.

The general physical characters of the people are thus described :—

Height.—The men are mostly of a slight but athletic build ; and though tall men are occasionally to be met with among them, they are, as a rule, considerably below the average Irish stature. The Aran average is 1645 mm., or about 5 feet 4⅜ inches ; that of 277 Irishmen is 1740 mm., or 5 feet 8½ inches.

Limbs.—The span is less than the stature in a quarter of the cases measured, a rather unusual feature in adult males. The hands are rather small, but the forearm is often unusually long.

Head.—The head is well shapen, rather long and narrow, but viewed from above, the sides are not parallel, there being a slight parietal bulging.

The mean cephalic index, when reduced to the cranial standard, is 75·1, consequently the average head is, to a slight extent, mesaticephalic ; although, as a matter of fact, the number measured is nearly evenly divided between mesaticephalic and dolichocephalic. The top of the head is well vaulted, so that the height above the ears is considerable.

The forehead is broad, upright, and very rarely receding ; not very high in most cases. The superciliary ridges are not prominent.

Face.—The face is long and oval, with well-marked features. The eyes are rather small, close together ; they are marked at the outer corners by transverse wrinkles. The irises are in the great majority of cases blue or blue-grey in colour. The nose is sharp, narrow at the base, and slightly sinuous or aquiline in profile. The lower lip is, in many cases, rather large and full. The chin is well developed. The cheek-bones are not prominent. In quite a large proportion of cases, the ears, though not large, stand well out from the head. In many men the length between the nose and the chin has the appearance of being decidedly great. The complexion is clear and ruddy, and but seldom freckled. On the whole, the people are decidedly good-looking.

Hair.—The hair is brown in colour, in most cases of a light shade, and accompanied by a light and often reddish beard. As a rule, the hair on the face is moderately well developed.

Sight and Hearing.—The sight and hearing of the people are, as a rule, exceedingly keen, especially the former. The range and distinctness of the vision is astonishing, as we have had occasion to know ; and we are informed by Dr. Kean that, on a clear day, any of the men whose eyesight is average can, with the naked eye, make out a small sailing-boat at Black Head, twenty miles away, before he can see it with a good binocular.

The observations of the authors tend to show that the natives of Inishmaan are rather lighter than the Aranmore men.

The population is decreasing, but as the number of births is considerably in excess of the deaths, the decrease must be attributed to emigration. That some of the inhabitants live to a very advanced age is evidenced by the fact that a tombstone in Killeany records the death of a man in the 119th year of his age.

The islanders appear to be exceptionally honest, straightforward and upright in their dealings, and illegitimacy is almost unknown.

They are singularly non-musical, there being no piper, fiddler, or musician of any sort on the islands.

The majority of the people can understand and speak English, but Irish is the language most generally spoken among themselves.

Almost all the marriages take place immediately before Lent. There is no courting or love-making, but the young man who has decided to marry goes to the house where there is a suitable girl, and asks her to marry him ; a man has been known to ask three girls in the same evening before he was accepted.

Wakes are held even upon those who die abroad. Occasionally a funeral procession stops on the road to the cemetery at certain spots, and the mourners raise small memorial heaps of stones ; in Aranmore there are about two dozen of these roadside monuments ; but the practice does not seem to date back beyond the beginning of the last century, and appears to have died out within the last twenty years.

The Aranites believe in fairies, banshees, and ghosts ; and a corpse is always carried out of a house through the back door.

It is said that if anyone at a marriage repeats the benediction after the priest, and ties a knot on a piece of string at the mention of each of the three sacred names, that marriage will be childless for fifteen years, or until the knotted string has been burnt.

Pin-wells and rag-bushes are still frequented, and on the night before emigrating people will sleep in the open, beside one of the holy wells, in order that they may have good fortune in the country to which they are going. There is a firm belief in the power of the Evil Eye, and on certain days that are considered unlucky, even burials are avoided.

The antiquities of the Aran Islands are numerous and varied, but have never yet been systematically described; and the authors urge upon the Irish Academy the desirability of its undertaking a detailed survey of them.

No opinion is expressed as to what race or races the Aranites belong, but it is argued that they cannot be Firbolgs, if the latter are correctly described as "small, dark-haired, and swarthy."

A short bibliography is given at the end of the paper, and a few photographs, taken by Prof. Haddon, give a general idea of the appearance of the people.

ELECTRICAL SANITATION.

A PRACTICAL application of electricity to sanitation has recently been made. Two systems have been tested upon a very considerable scale, in both of which the electrolytic action of the current has been utilised.

The two methods at present before the public are Mr. William Webster's, which is being carried out by the Electrical Purification Association (Limited), and that ascribed to Mr. Eugene Hermite, and worked by him in conjunction with Messrs. Paterson and Cooper.

As has occurred so frequently before, both these inventors appear to have conceived the same idea about the same time. Each of them took out three patents in the year 1887, but though each had the same object in view, and although in their early patents they seemed almost to be running on the same rather than on parallel lines, their recent practice is quite distinct.

Mr. Webster treats the sewage directly. He places parallel iron electrodes within a conduit or shoot, through which the sewage is passed, the electrodes being alternately connected with the positive and negative poles of a dynamo. The nascent ammonia thus evolved at the negative electrode produces an alkaline reaction, which effects the precipitation of the solid suspended matter, while at the positive pole nascent oxygen and chlorine are evolved, producing an acid reaction, whereby the organic impurities held in suspension or solution are readily decomposed and purified.

This system has been tested on a large scale, both at Crossness and at Salford. The amount of sludge formed is said to be smaller than in any precipitation process, and the effluent so pure as not to require further treatment by filtration. The process has been reported on in the most favourable manner, as regards the chemical tests of the effluent, and the ease and uniformity with which the results are obtained.

Mr. Hermite's system consists in the treatment of sea water or other chloride solutions by electrolysis. The water thus electrolysed in reservoirs is conducted as a disinfecting liquid by suitable pipes to places requiring disinfection, where it is stored in cisterns and used in place of ordinary water. The system has been experimentally tested at Havre, Lorient, Brest, and Nice, and has been reported upon most favourably in every case. It is now being tried at Worthing, where an installation has been set up under the auspices of the Mayor and corporation. As in the previous system, an oxygenated compound of chlorine is held to be produced, which burns up the sewage matter, and absolutely destroys all microbes.

Several questions have to be considered from a scientific and practical point of view, in connection with both these inventions, before their general application can be effected. The scientific view of the subject, after all, resolves itself into the answer to a single question: Is the process quite trustworthy to remove the maximum of organic matter from the sewage, and thoroughly sterilise it? As regards the practical point of view, the removal and utilisation of the sludge will have to be faced, in the first process referred to; whilst in the second, in which sludge is said not to be produced, a second water supply to houses, and the chemical action of this disinfecting water upon the pipes, tubes, and reservoirs through which it has to pass, will have to be very fully considered before the system can be adopted.

ON HOMOGENEOUS DIVISION OF SPACE.[1]

II.

§ 10. NOW, suppose any one pair of the tetrahedrons to be taken away from their positions in the primitive parallelepiped, and, by purely translational motion, to be brought into position with their edges of length QD coincident, and the same to be done for each of the other two pairs. The sum of the six angles at the coincident edges being two right angles, the plane faces at the common edge will fit together, and the condition of parallelism in the motion of each pair fixes the order in which the three pairs come together in the new position, and shows us that in this position the three pairs form a parallelepiped essentially different from the primitive parallelepiped, provided that, for simplicity in our present considerations, we suppose each tetrahedron to be wholly scalene, that is to say, the seven lengths found amongst the edges to be all unequal. Next shift the tetrahedrons to bring the edges QE into coincidence, and next again to bring the edges QF into coincidence. Thus, including the primitive parallelepiped, we can make four different parallelepipeds in each of which six of the tetrahedrons have a common edge.

§ 11. Now take the two pairs of tetrahedrons having edges of length equal to QA, and put them together with these edges coincident. Thus we have a scalene octahedron. The remaining pair of tetrahedrons placed on a pair of its parallel faces complete a parallelepiped. Similarly two other parallelepipeds may be made by putting together the pairs that have edges of lengths equal to QB and QC respectively with those edges coincident, and finishing in each case with the remaining pair of tetrahedrons. The three parallelepipeds thus found are essentially different from one another, and from the four of § 10; and thus we have the seven parallelepipeds fulfilling the statement of § 9. Each of the seven parallelepipeds corresponds to one and the same homogeneous distribution of points.

§ 12. Going back to § 4, we see that, by the rule there given, we find four different ways of passing to the tetrakaidekahedron from any one chosen parallelepiped of a homogeneous assemblage. The four different cellular systems thus found involve four different sets of seven pairs of neighbours for each point. In each of these there are four pairs of neighbours in rows parallel to the three quartets of edges of the parallelepiped and to the chosen body-diagonal; and the other three pairs of neighbours are in three rows parallel to the face-diagonals which meet in the chosen body-diagonal. The second (§ 11) of the two modes of putting together tetrahedrons to form a parallelepiped which we have been considering suggests a second mode of dividing our primitive parallelepiped, in which we should first truncate two opposite corners and then divide the octahedron which is left, by two planes through one or other of its three diagonals. The six tetrahedrons obtained by any one of the twelve ways of effecting this second mode of division give, by their twenty-four corners, the twenty-four corners of a space-filling tetrakaidekahedronal cell, by which our fundamental problem is solved. But every solution thus obtainable is clearly obtainable by the simpler rule of § 4, commencing with some one of the infinite number of primitive parallelepipeds which we may take as representative of any homogeneous distribution of points.

§ 13. The communication is illustrated by a model showing the six tetrahedrons derived by the rule 4 from a symmetrical kind of primitive parallelepiped, being a rhombohedron of which the axial-diagonal is equal in length to each of the edges. The homogeneous distribution of points corresponding to this form of parallelepiped is the well known one in which every point is surrounded by eight others at the corners of a cube of which it is the centre; or, if we like to look at it so, two simple cubical distributions of single points, each point of one distribution being at the centre of a cube of points of the other. To understand the tactics of the single homogeneous assemblage constituted by these two cubic assemblages, let P be a point of one of the cubic assemblages, and Q any one of its four nearest neighbours of the other assemblage. Q is at the centre of a cube of which P is at one corner. Let PD, PE, PF be three conterminous edges of this cube so that A, B, C are points of the first assemblage nearest to P. Again Q is a corner of a cube of which P is the centre; and if QA, QB, QC are three conterminous edges of this cube, D, E, F are points of the second assemblage

[1] A paper read before the Royal Society on January 18, by Lord Kelvin, P.R.S. (Continued from p. 448.)

nearest to Q. The rhombohedron of which PQ is body-diagonal and PA, PB, PC the edges conterminous in P, and QD, QE, QF

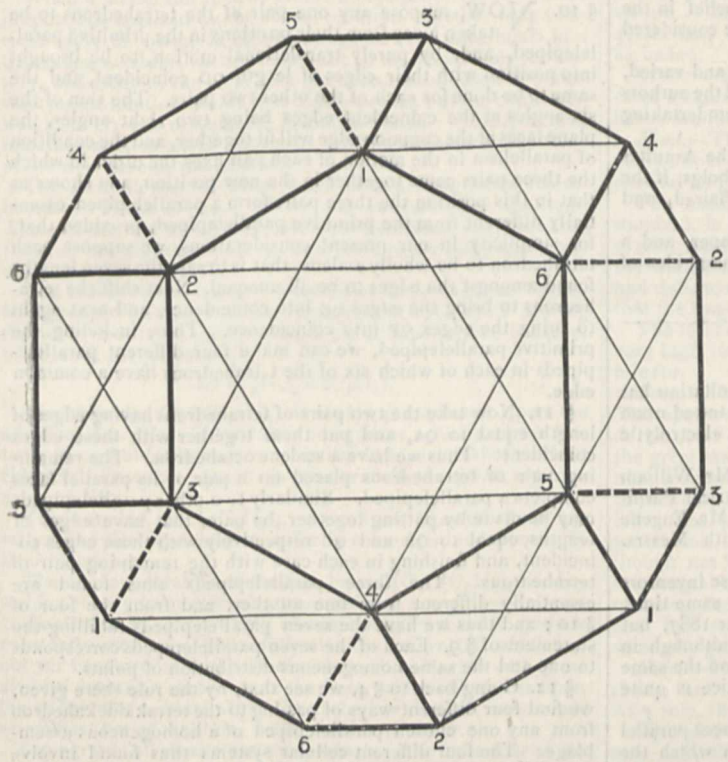


FIG. 8.

the edges conterminous in Q, is our present rhombohedron. The diagram of § 9 (Fig. 7), imagined to be altered to proper proportions for the present case, may be looked to for illustration. Its three face-diagonals through P, being PD, PE, PF, are perpendicular to one another. So also are QA, QB, QC, its three face-diagonals through Q. The body-diagonal of the cube PQ, being half the body diagonal of the cube whose edges are PD, PE, PF, is equal to PD $\times \frac{1}{2}\sqrt{3}$: and PA, PB, PC are also each of them equal to this, because A, B, C are centres of other equal cubes, having P for a common corner.

§ 14. The tetrahedrons used in the model are those into which the parallelepiped is cut by three planes through the axial diagonal, which in this case cut one another at angles of 60°. We wish to be able to shift the tetrahedrons into positions corresponding to those of the triangles in Fig. 1, which we could not do if they were cut out of the solid. I, therefore, make a mere skeleton of each tetrahedon, consisting of a piece of wire bent at two points, one-third of its length from its ends, at angles of $70\frac{1}{2}°$, being $\sin^{-1}\frac{1}{3}\sqrt{3}$, in planes inclined at 60° to one another. The six skeletons thus made are equal and similar, three homochirals and the other three also homochirals, their enantiomorphs. In their places in the primitive parallelepiped they have their middle lines coincident in its axial diagonal PQ, and their other 6×2 arms coincident in three pairs in its six edges through P and Q. Looking at Fig. 7 we see, for example, three of the edges CP, PQ, QE, of one of the tetrahedrons thus constituted; and DQ, QP, PB, three edges of its enantiomorph. In the model they are put together with their middle lines at equal distances around the axial diagonal and their arms symmetrically arranged round it. Wherever two lines cross they are tied, not very tightly, together by thin cord many times round, and thus we can slip them along so as to bring the six middle lines either very close together, nearly as they would be in the primitive parallelepiped, or farther and farther out from one another so as to give, by the four corners of the tetrahedrons, the twenty-four corners of all possible configurations of the plane-faced space-filling tetrakaidekahedron.

§ 15. The six skeletons being symmetrically arranged around an axial line we see that each arm is cut by lines of other skeletons in three points. For an important configuration, let the skeletons be separated out from the axial line just so far that each arm is divided into four equal parts, by those three intersectional points. The tetrakaidekahedron of which the twenty-four corners are the corners of the tetrahedrons thus placed may conveniently be called the orthic tetrakaidekahedron. It has six equal square faces and eight equal equiangular and equilateral hexagonal faces. It was described in § 12 of my paper on "The Division of Space with Minimum Partitional Area" (*Philosophical Magazine* 1887, second half year, and *Acta Mathematica*, vol. xi. pp. 121-124), under the name of "plane-faced isotropic tetrakaidekahedron"; but I now prefer to call it orthic, because, for each of its seven pairs of parallel faces, lines forming corresponding points in the two faces are perpendicular to the faces, and the planes of its three pairs of square faces are perpendicular to one another. Fig. 8 represents an orthogonal projection on a plane parallel to one of the four pairs of hexagonal faces. The heavy lines are edges of the tetrakaidekahedron. The light lines are edges of the tetrahedrons of § 13, or parts of those edges not coincident in projection with the edges of the tetrakaidekahedron. The figures 1, 1, 1; 2, 2, 2; . . .; 6, 6, 6 show corners belonging respectively to the six tetrahedrons, two of the four corners of each being projected on one point in the diagram. Fig. 9 shows, on the same scale of magnitude with corresponding distinction between heavy and light lines, the orthogonal projection on a plane parallel to a pair of square faces.

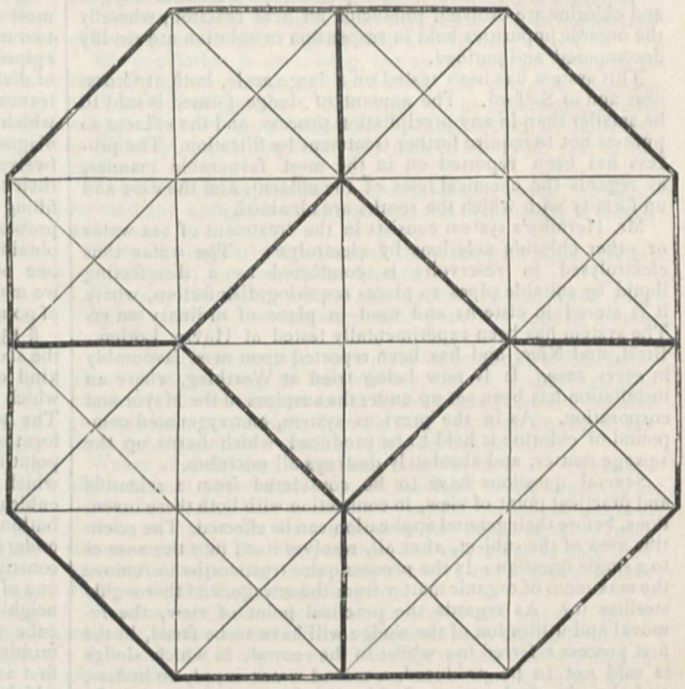


FIG. 9.

§ 16. If the rule of § 15 with reference to the division of each arm of a skeleton tetrahedron into four equal parts by points in

which it is cut by other lines of skeletons is fulfilled with all details of §§ 14 and 15 applied to any oblique parallelepiped, we find a tetrakaidekahedron which we may call orthoid, because it is an orthic tetrakaidekahedron, altered by homogeneous strain. Prof. Crum Brown has kindly made for me the beautiful model of an orthoidal tetrakaidekahedron thus defined which is placed before the Royal Society as an illustration of the present communication.

Fig. 10 is a stereoscopic picture of an orthic tetrakaidekahedron, made by soldering together thirty-six pieces of wire, each 4 in. long, with three ends of wire at each of twenty-four corners.

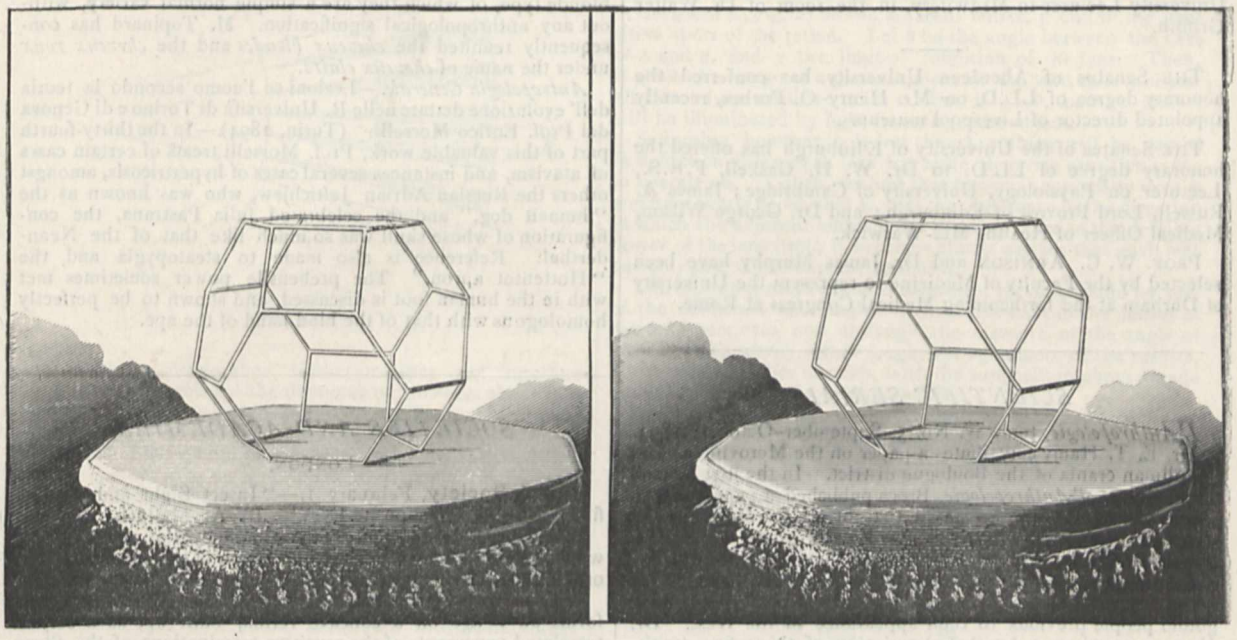


FIG. 10.

§ 17. I cannot in the present communication enter upon the most general possible plane-faced partitional tetrakaidekahedron or show its relation to orthic and orthoidal tetrakaidekahedrons. I may merely say that the analogy in the homogeneous division of a plane is this:—an equilateral and equiangular hexagon (orthic); any other hexagon of three pairs of equal and parallel sides whose paracentric diagonals trisect one another (orthoidal). The angles of an orthoidal hexagon, other than equilateral, are not 120°. The angles of the left-hand hexagon Fig. 1 (§ 7) are 120°, and its paracentric diagonals do not trisect one another, as the diagram clearly shows.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Cambridge University Natural Science Club celebrated its 500th meeting by a conversazione in the University Physiological Laboratory on March 12. This club was an early outcome of the development of natural science in the University, being founded on March 10, 1872. Its members are drawn from the senior science students in the University. Among the original members (nine in number) may be mentioned Dr. H. Newell-Martin, Prof. Liversidge (now at Sydney), and the late Dr. P. H. Carpenter. At one of the earliest meetings the late Prof. F. M. Balfour was elected. Two years later saw Prof. S. H. Vines and the late Prof. Milnes Marshall added to the list of members. It is interesting to note that the first volume of "Studies from the Physiological Laboratory, Cambridge," published in 1873, contained contributions from four of the original members of the club. At that time this laboratory, which is now large enough to accommodate easily a large conversazione, consisted (in the words of Prof. M. Foster) of "two rooms in which my lectures are given, the practical teaching of my class conducted, and the physiological work carried on." So that the interval between the first and 500th meetings of the Science Club represents an important epoch in the history of the Cambridge Science School, and gives to the conversazione a special interest.

Although the aggregate number of members in the club during these twenty-two years only slightly exceeds 150, it may be observed that this number includes sixteen Fellows of the Royal Society and eighteen Professors holding Chairs in British and colonial universities and colleges. In addition to these a considerable number of university and college lecturers have belonged to its membership during their student days, so that the club may fairly claim to have borne its part in the scientific teaching of the day.

The conversazione of the club, held on Monday, was attended by about 600 persons, including a considerable number of eminent men of science, both British and Continental. The Physiological Laboratory was gaily decorated for the occasion, and many exhibits in the different branches were on view. Prof. Ramon y Cajal kindly showed specimens illustrating the histology of the central nervous system. The Botanical Department included exhibits by Mr. F. Darwin, F.R.S., and Mr. W. Gardiner, F.R.S.; demonstrations in electricity were given by Prof. J. J. Thomson, F.R.S. One large room was devoted to the exhibition of scientific instruments and machines in motion, among which we might mention engineering apparatus, shown by Prof. Ewing, and Callendar's new pyrometer, by the Cambridge Scientific Instrument Company. Chemistry, geology, physiology, and pathology were also well represented. The Anatomical Museum was occupied by the Ethnological Department, under the direction of Prof. MacAlister, Mr. Hickson, Prof. A. C. Haddon, and Baron von Hügel. A great feature of the evening was in the lecture theatre, where Dr. A. R. Wallace, F.R.S., delivered a polemic on "Geographical Distribution," while Prof. C. V. Boys, F.R.S., lectured on "The Photography of Flying Bullets," and Mr. Martin Conway on his recent travels in high altitudes among the Himalayas.

Dr. Donald MacAlister, Fellow and Tutor of St. John's College, has been appointed Linacre Reader of Physic, in succession to Dr. Bradbury, the new Downing Professor of Medicine. Dr. MacAlister was Senior Wrangler and First Smith's Prizeman in 1877.

Prof. Foster has been appointed a delegate to represent the University at the eleventh International Medical Congress to be held this month in Rome.

Dr. Anningson, Medical Officer of Health for Cambridge,

and Dr. D. MacAlister, Assessor to the Regius Professor of Physic, have been appointed to represent the University at the International Congress of Hygiene and Demography to be held in September next in Budapest.

Mr. F. Darwin has been appointed an Elector to the Professorship of Botany, Prof. Ray Lankester an Elector to the Professorship of Zoology, Dr. G. J. Hinde an Elector to the Professorship of Geology, and the Rt. Hon. T. H. Huxley an Elector to the Professorship of Physiology, for the next eight years.

Mr. E. H. Douty, of King's College, has been appointed University Lecturer in Midwifery, in the room of Dr. Walter Griffith.

THE Senatus of Aberdeen University has conferred the honorary degree of LL.D. on Mr. Henry O. Forbes, recently appointed director of Liverpool museums.

THE Senatus of the University of Edinburgh has offered the honorary degree of LL.D. to Dr. W. H. Gaskell, F.R.S., Lecturer on Physiology, University of Cambridge; James A. Russell, Lord Provost of Edinburgh; and Dr. George Wilson, Medical Officer of Health, Mid-Warwick.

PROF. W. C. ARNISON and Dr. James Murphy have been selected by the Faculty of Medicine to represent the University of Durham at the forthcoming Medical Congress at Rome.

SCIENTIFIC SERIALS.

L'Anthropologie, tome iv. No. 5, September–October, 1893.—Dr. E. T. Hamy contributes a paper on the Merovingian and Carolinian crania of the Boulogne district. In the first volume of the *Revue d'Anthropologie*, Broca published a paper on the nasal index, in which he stated that of all European groups whose crania he had measured, the French group of Chelles, Champlieu, &c. was alone *mesorhine*, having a mean nasal index of 48 87, and he concluded that this anatomical peculiarity was derived from a cross with some more or less Mongoloid people previous to their appearance in the West. Dr. Hamy now gives a detailed description of thirty-five crania, twenty male and fifteen female, taken from four Merovingian burial-places in the Boulogne district, and in the second part of the paper he gives a comparative study of the crania, of a later date, exhumed by M. l'Abbé Debout from the mound of Tardinghen; some of them from the surface, and others from graves beneath flagstones, the Merovingian age of the former being clearly indicated by the articles buried with the bodies, and the latter probably belonging to the end of the Carolinian period. A critical examination of these crania leads to the conclusion that the original type of the inhabitants was altered by foreign occupation, and that the elements thus violently introduced were eliminated little by little, and the primitive population, thrown into the shade for a while, gradually regained their supremacy. Undoubtedly there remain on the coast of the Channel, especially on the Pas-de-Calais, many tall and strong men, with fair hair, ruddy complexion, narrow head, and long face, who represent, to some extent at least, with fidelity the Saxons or Franks from whom they are descended, but the brunettes who surround them are more numerous than they, and are gradually absorbing them. To take one example only: in the canton of Marquise, the school population, consisting of 1750 boys and girls, yields 913 subjects with dark hair (of whom 163 have black hair), against 779 blondes (54 of whom have red hair); consequently 52·2 per cent. are dark, and only 47·8 per cent. fair, and as these are for the most part children whose hair has not yet attained its final colour, some of those now classed as blondes will become brunettes as adults.—M. E. Deschamps describes some instances of albinism observed by him at Mahé, on the coast of Malabar, and M. Salomon Reinach contributes the first part of a vigorous attack on "Le Mirage Oriental," in which he argues that credit has been given to the East for a far greater influence upon European civilisation than has really been exercised by it. Mycenæan civilisation is entirely of European origin; it is only orientalised on the surface by contact with the civilisations of Syria and of Egypt. Greece, the Archipelago, and the coast of Asia Minor are the places where, in a remote antiquity, European, Asiatic, and Egyptian influences mingled.—Dr. P. Topinard continues his memoirs on the distribution of the colour of the eyes and of the hair in France, the subject of the present essay being the chart of red hair. He arrives at the following conclusions: (1) That, as in the British Isles, where red hair is comparatively common, and in Italy, Turkey, and Armenia, where it is seldom met with, so in France it is more commonly found in the middle of the country than elsewhere; (2) that in those French departments in which the blonde type predominates, red hair is twice or three times as frequent as in those inhabited by people with dark hair; (3) that, probably, red-haired people are allied exclusively to the blonde type, of which they are a simple normal variety, without any anthropological signification. M. Topinard has consequently reunited the *cheveux blondes* and the *cheveux roux* under the name of *cheveux clairs*.

Antropologia Generale.—Lezioni su l'uomo secondo la teoria dell' evoluzione dettate nelle R. Università di Torino e di Genova dal Prof. Enrico Morselli. (Turin, 1894).—In the thirty-fourth part of this valuable work, Prof. Morselli treats of certain cases of atavism, and instances several cases of hypertricosis, amongst others the Russian Adrian Jeftichjew, who was known as the "human dog," and the celebrated Julia Pastrana, the configuration of whose skull was so much like that of the Neanderthal. Reference is also made to steatopygia and the "Hottentot apron." The prehensile power sometimes met with in the human foot is discussed, and shown to be perfectly homologous with that of the hind-hand of the ape.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 1.—"Insect Sight and the Defining Power of Composite Eyes." By A. Mallock.

The optical arrangement of the simple eyes of vertebrates is well understood, but as regards the action of the composite eyes of insects and crustacea less certainty has hitherto prevailed.

In the former class of eye a single lens, or its equivalent, forms an image on a concave retina, built up, as a sort of tesselated pavement, of the sensitive terminations of the fibres of the optic nerve, and, if the lens is perfect and the pupil large enough, the definition is limited by the distance apart of the nerve-terminations, for, in order that two objects may appear as two to the eye, they must subtend at least such an angle that their images as formed by the lens shall not fall on the same nerve-termination.

In the human eye the distance between the sensitive points on the retina is such that it subtends about a minute of arc at the optic centre of the lens, and in good eyes the optical part of the apparatus is sufficiently perfect to allow of this degree of definition being attained over a small part of the field of view.

For reasons, however, which will be given presently, such definition as this is not to be looked for in composite eyes.

The general plan on which all composite eyes are constructed is that of a convex retina having a separate small lens in front of each sensitive part, together with an arrangement of screens which allows only that light coming from the immediate neighbourhood of the axis of the lens to reach the nerve.

The theory of "mosaic vision" put forward by Johannes Müller has been opposed by some physiologists who appear to have considered that each lens of a composite eye formed a complete image which was taken cognisance of by the nerves as in the vertebrate eye, and that the whole of these images were in some way added together and arranged by the brain. I here bring forward some optical reasons which show that Müller's view is the true one.

On the supposition, therefore, of "one lens, one impression," the definition obtained by a composite eye will be measured by the total solid angle of view ÷ whole number of lenses in the eye.

The simplest form of composite eye would be a spherical shell, AB, Fig. 1, perforated with radial holes, *c*, *c*, *c*, the diameter of these holes being small compared with the thickness of the shell.

If sensitive paper were placed in contact with the inner surface of the shell, it would be impressed with a picture of surrounding objects, for the light which reaches the bottom of any hole is limited to that making an angle less than ½DEF with the

axis of the hole, which angle is of course equal to the diameter of the hole ÷ half its length.

It is interesting to see what proportions would have to be given to an eye of this kind if the definition is to be as good as that of the human eye.

The limit of definition in this case being 1 min., the holes would have to be 7000 diameters long (since 1 min. is nearly

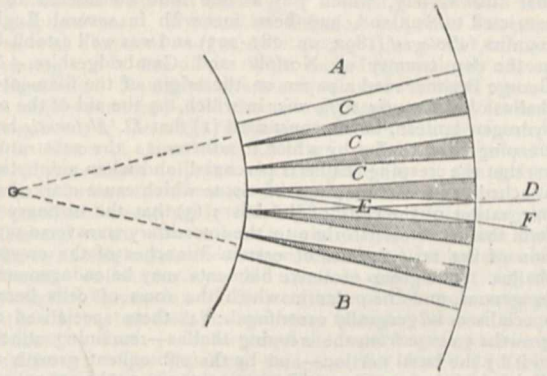


FIG. 1.

1/3500), and in order that diffraction may not interfere materially with the result,[1] the diameter of the holes should not be less than 2000 wave-lengths of light, say $\frac{1}{125}$ in. Hence the thickness of the shell will be 7000 × $\frac{1}{125}$ in., or 23 ft.

The radius of the sphere may be determined by the condition that, if the picture is to be continuous, the adjacent holes must just be in contact at the internal surface of the shell, that is to say, the diameter of the hole, viz. $\frac{1}{125}$ in., must subtend 1 min. at the internal radius of the shell, which makes this radius therefore 11 ft. 6 in.

Thus an eye of this construction and power of definition would consist of some part of a spherical shell of 34 ft. 6 ins. external radius, and 23 ft. thick, perforated with radial holes $\frac{1}{125}$ in. in diameter, and with their centres about $\frac{1}{8}$ apart on the external surface.

If still keeping 1 min. as the limit of definition, we substitute the arrangement actually found in composite eyes, and in place of the long tunnels in thick shell, we use short tunnels with a lens at the outer end of each tunnel, and a diaphragm at the inner end, pierced with a small central hole (Fig. 2), the pro-

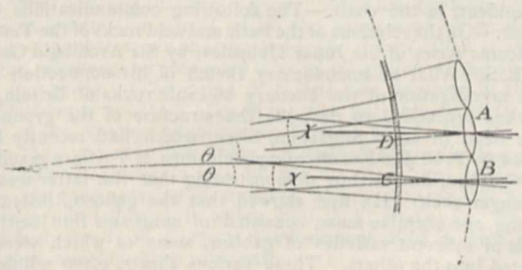


FIG. 2.

portions of the eye will be determined in the first place by the diameter of the lens which will just define 1 min., and secondly by making that diameter subtend 1 min. at the centre of the sphere.

Now the size of the image of a point formed by a lens (as seen from the optic centre of the lens) is inversely as the diameter of the lens, and it takes a lens 4 ins. in diameter to define 1 second, *i.e.* to separate points 1″ apart; hence the lens which will just define 1 min. is $\frac{4}{60}$ or 0·066 in. in diameter.

[1] It may be shown that the hole should not be much smaller than the first Huyghens zone of a system for which, if $\lambda/r = r/R$, R = the length of the hole, λ and *r* being the wave-length of light and the radius of the zone respectively. How much less than *r* the diameter of the hole may be is, to some extent, a matter of judgment depending on the degree to which it is considered desirable to reduce the intensity of the diffracted light.

The radius at which 0·066 in. subtends 1 min. is about 19 ft.

It is evident, therefore, that no composite eye of practicable dimensions, acting as supposed above, could be made to give definition even approaching that of the human eye.

If the diameter of the lenses is reduced, not only is the size of the sphere on which a given number of them would lie reduced, but, since the definition of each lens decreases with the diameter, a less number of lenses will be required to give the maximum definition attainable under the changed circumstances. Thus the radius of the sphere proper for the surface of a composite eye decreases as the square of the defining power of the separate lenses of which it is composed.

Let A and B (Fig. 2) be two adjacent lenses, C and D the sensitive spots of the retina. Let θ be the angle between the axes of A and B, and χ the limit of definition of the lens. Then, if $\chi = \theta$, the image of a distant object in the axis of A will just all clear of the sensitive point D, but if $\chi > \theta$, both C and D will be illuminated by light from the same object.

Supposing, however, χ is less than θ, nothing will be gained in definition unless each lens has more than one sensitive point to operate on. If, then, we find that in actual composite eyes χ and θ are nearly equal, that is, that the difference in the direction in which the adjacent lenses point is nearly equal to the defining power of the lens itself, it becomes almost certain that each lens has only one sensitive point behind it.

The following table contains measures, recently made by me, of the diameters and angles between the axes of the lenses of various insect eyes, and although the measure of the angle of view was necessarily rather rough, the agreement of the results, in the larger number of cases, with the supposition above, made seems to me sufficiently remarkable.

In estimating θ there were two difficulties, one of which was that in many eyes the curvature of the surface was sharp at the margin and that the definition was probably bad there, and another that the line of sight of each lens was not always normal to the outer surface of the eye (Fig. 3). Generally I took the

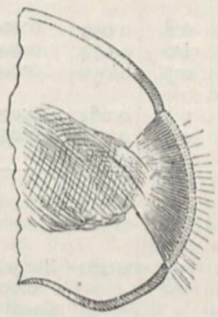


FIG. 3.

angle between the tangents to the surface at the ends of a measured chord, choosing the chord so that the surface outside it should have fairly uniform curvature. The length of the chord was usually about three-quarters, or a little more, of that of the eye.

Taking the length of the chord as *l*, and *r* as radius of the sphere which best represents the surface of the eye, we have for the angle of view Θ,

$$\sin \tfrac{1}{2}\Theta = l/2r,$$

and $\theta = d/r$, where *d* is the diameter of the lens

hence $$\theta = d/b \,.\, 2 \sin \tfrac{1}{2}\Theta$$

The other columns of the table explain themselves.

On the whole, I think it must be concluded that insects do not see well, at any rate as regards their power of defining distant objects, and their behaviour certainly favours this view; but they have an advantage over simple-eyed animals in the fact that there is hardly any practical limit to the nearness of the objects they can examine. With the composite eye, indeed, the closer the object the better the sight, for the greater will be the number of lenses employed to produce the impression; whereas in the simple eye the focal length of the lens limits the distance at which a distinct view can be obtained.

The best of the eyes mentioned in the table would give a picture about as good as if executed in rather coarse wool-work and viewed at a distance of a foot; and, although a distant

landscape could only be indifferently represented on such a coarse-grained structure, it would do very well for things near enough to occupy a considerable part of the field of view.

Species.	Length of body.	Greatest dimension of eye.	Diameter of aperture of eyelet.	Angle between axes of adjacent eyelets in minutes.	Defining power of lens of diameter d in minutes.
			d.	s	χ
Diptera—					
1. Fly like a bee, *Eristalis* ...	0·60	0·108	0·0012	56	55
2. Fly like a wasp, *Sericomyia* ...	0·70	0·12	0·0016	48	71
3. Blow-fly, *Lucilla*	0·34	0·07	0·0018	84	35
4. Very small flies, species not identified	0·20	0·026	0·00076	126	87
5. Ditto	0·13	0·021	0·0005	105	113
Hymenoptera—					
6. Hornet	1·0	0·152	0·0014	53	48
7. Wasp	0·7	0·088	0·0011	84	60
8. Bee	0·6	0·100	0·00072	50	90
9. *Chrysis*, scarlet and blue ...	0·4	0·045	0·00094	105	70
Lepidoptera—					
10. Small cabbage white	0·8	0·059	0·00072	86	90
11. Red admiral...	1·0	0·072	0·00095	76	69
12. Small copper	0·5	0·050	0·00071	100	93
13. Yellow under wing	0·75	0·064	0·00092	70	72
14. *Noctua*	0·7	0·060	0·00090	70	74
Dragon-flies—					
15. Large dragon-fly, *Æschna cyanea*	3·5	0·282	Large lenses 0·0023		
			Small lenses 0·0016	48	41
16. *Libellula striolata*	2·5	0·191	Large lenses 0·0027		
			Small lenses 0·0015	50	45
17. Green grasshopper	1·1	0·057	0·0011	80	60
18. *Tipula*	1·0	0·027	0·00095	200	70

Linnean Society, February 15.—Prof. Stewart, President, in the chair.—Dr. Maxwell Masters exhibited a remarkably good specimen of *Peziza tuberosa* on root of *Anemone*. It is only comparatively recently that the hard lumps (sclerotia) in the soil of anemone beds have been definitely associated with the fruit of this *Peziza*; at one time the sclerotia were regarded as diseased masses of the root-stock. Dr. Masters also exhibited some root-galls on plum caused by *Cynips* (*Biorhiza*) *terminalis*. Mr. Cameron, in his monograph on the *Cynipidæ*, published by the Royal Society, has noticed galls formed by this insect on the beech, pine, and vine, but not on the plum.—Mr. Digby Nicholl exhibited a singular variety of the partridge (*Perdix cinereæ*), which had been shot by Mr. A. Waugh, near Creswell, Northumberland, in September 1893. In colour it resembled the red grouse, having the breast and flanks suffused with large patches of dark reddish-brown, and the dorsal plumage very much darker than usual. Mr. Harting pointed out that this variety was described and figured by the late John Hancock in his "Catalogue of the Birds of Northumberland," where it had been met with more than twenty years ago, and in which county he himself had also procured a specimen at Corbridge-on-Tyne, which was preserved in the collection of varieties formed by the late Mr. F. Bond.—Mr. Norman Douglass exhibited a black variety of the water-vole, *Arvicola amphibius*, captured at Banchory, Kincardineshire; remarking that this variety, which was at one time considered to be restricted to Scotland, had been met with in several English counties (*Zoologist*, 1892, pp. 281–293) and was well established in the fen country of Norfolk and Cambridgeshire.—Mr. George Brebner read a paper on the origin of the filamentous thallus of *Dumontia filiformis*, in which, by the aid of the oxy-hydrogen lantern, he demonstrated (1) that *D. filiformis* has a creeping basal thallus by which it adheres to the substratum; (2) that the creeping thallus is perennial, and when epiphytic is attached to its host by plugs of tissue which cause marked disintegration of the cells of the host; (3) that the ordinary filiform thallus owes its origin to the intercalary transverse septation of the articulations of certain branches of the creeping thallus. The group of active filaments may be endogenous or exogenous, and the order in which the rows of cells became specialised is generally centrifugal; (4) these specialised outgrowths emerge from the creeping thallus—remaining attached to it by the basal portion—and by the subsequent growth and division of the constituent filaments give rise to the annual well known *D. filiformis* thallus. The paper, which was listened to with great interest, was criticised by Dr. D. H. Scott, Mr. George Murray, and others.—On behalf of Mr. D. J. Scourfield, a paper was communicated by Prof. Miall, on Entomostraca and the surface-film of water. Briefly summarised, the principal views advanced in this paper were the following: (1) To many Entomostraca the surface film of water is a very dangerous element in their environment; to this category belong large numbers of the Cladocera and Ostracoda; (2) to some other Entomostraca, conversely, the surface film affords peculiar advantages. This class includes, so far as yet known, only a few specially modified Cladocera and Ostracoda, and some Copepods, which do not, however, present any apparent structural modifications; (3) in all cases (except where some Copepods possibly make use of the properties of the surface-film to attach themselves to aquatic plants above the general water-level) the relation to the surface-film, whether beneficial or the reverse, depends fundamentally upon the same physical principles, namely, the upward pull of the surface-film when forming a capillary depression, and the possession by the animals of water-repellent shells, ridges, scales, or setæ, capable of penetrating the surface-film, and producing capillary depressions.

Geological Society, Feb. 21.—Dr. H. Woodward, F.R.S. President, in the chair.—The following communications were read:—On the relations of the basic and acid rocks of the Tertiary volcanic series of the Inner Hebrides, by Sir Archibald Geikie, F.R.S. After an introductory sketch of his connection with the investigation of the Tertiary volcanic rocks of Britain, the author proceeded to describe the structure of the ground at the head of Glen Sligachan, Skye, which had recently been cited by Prof. Judd as affording inclusions of Tertiary granite in the gabbro, and as thus demonstrating that the latter was the younger rock. He first showed that the gabbro, instead of being one eruptive mass, consisted of numerous thin beds and sills of different varieties of gabbro, some of which were injected into the others. These various sheets, often admirably banded, were seen to be truncated by the line of junction with the great granophyre-tract of Glen Sligachan. A large mass of coarse agglomerate was likewise cut off along the same line. These structures were entirely opposed to the idea of the gabbro being an eruptive mass which had broken through the granophyre. They could only be accounted for, either by a fault which had brought the two rocks together, or by the acid rock having disrupted the basic. But there was ample evidence that no fault occurred at the boundary-line. The granophyre became fine-grained, felsitic, and spherulitic along its margin, where it abutted against the complex mass of basic rocks. These structures continued altogether independent of the varying distribution of the gabbros, and were seen even where the granophyre ran along the side of the agglomerate. Similar structures were of common occurrence along the margins of the granophyre-bosses and sills of the Inner Hebrides, being found not only next the gabbro, but next the Jurassic sand-

stones and shales. They were familiar phenomena of contact in all parts of the world, and were sufficient of themselves to show that the granophyre of Skye must be later than the gabbro. The author then described three conspicuous dykes, from 8 feet to 10 feet broad, which could be seen proceeding from the main body of granophyre and cutting across the banded gabbros. One of these was traceable for more than 800 feet in a nearly straight line. The material composing these dykes was identical with that constituting the marginal portion of the granophyre-mass. It presented the most exquisite flow-structure, with abundant rows of spherulites. The author exhibited a photograph of one of the dykes ascending vertically through the gabbros. Numerous dykes and veins of the same material, not visibly connected with the main granophyre-mass, traversed the gabbros of the ridge of which Druim an Eidhne formed a part. Some of these were described, and it was shown that the flow-structure followed the irregularities of the gabbro-walls and swept round enclosed blocks of altered gabbro. The "inclusions" described by Prof. Judd were portions of these dykes and veins. There was not, so far as the author could discover, a single granite-block enclosed in the gabbro anywhere to be seen at this locality. He therefore claimed not only that his original description of the relations of the rocks was perfectly correct, but that the evidence brought forward to contradict it by Prof. Judd furnished the most crushing testimony in its favour. The President said that Sir Archibald Geikie had made out his case so clearly that no one, it might be supposed, could for a moment doubt that the interpretation which he had given was the correct and the only one; nevertheless, he had reason to believe that Prof. Judd had, with careful study, arrived at quite a different view of these same rocks. Prof. Judd criticised the paper at some length, and the author replied to his remarks.—Note on the genus *Naiadites*, as occurring in the coal formation of Nova Scotia., by Sir J. William Dawson, K.C.M.G., F.R.S. With an appendix by Dr. Wheelton Hind. The specimens referred to occur most abundantly in calcareo-bituminous shales along the coast, at the South Joggins, and were described by the author in "Acadian Geology," in 1860. A collection of them has been submitted to Dr. Wheelton Hind. In *Quart. Journ. Geol. Soc.* vol. xix. Mr. Salter referred the shells described as *Naiadites* to his new genera *Anthracoptera* and *Anthracomya*. In correspondence with Mr. Salter, the author held that the shells were probably fresh-water, and objected to the name *Anthracomya* as expressing an incorrect view of the affinity of the shells; he also stated several reasons in support of his opinions. The author continued to use the name *Naiadites*, but did not object to the division of the species into two genera, for one of which Salter's name *Anthracoptera* should be retained. Additional reasons were given for the fresh-water origin of these shells. Dr. Wheelton Hind believed that the "genus" *Naiadites* contained three distinct genera, for one of which the name must be retained. He proposed to retain the name for the forms called *Anthracomya*, affirming as this word does an altogether wrong affinity for the genus. (The name *Naiadites* was proposed in 1860; *Anthracomya* in 1861.) Dr. Hind was not able to state that any of the species submitted to him by Sir J. W. Dawson were the same as British forms. The shell originally described as *Naiadites carbonaria* was, he has no doubt, an *Anthracoptera*. He gave notes on *N. arenaria*, *N. angulata*, and *N. levis*. A discussion followed, in which Prof. J. F. Blake, Dr. W. T. Blanford, Dr. J. W. Gregory, the President, Prof. T. McKenny Hughes, and Mr. Marr took part.

Entomological Society, February 28.—Colonel Charles Swinhoe, Vice-President, in the chair.—Prof. August Forel, M.D., of the University of Zürich, was elected an Honorary Fellow of the Society, to fill the vacancy caused by the death of Prof. H. A. Hagen, M.D.—Mr. G. C. Champion called attention to a supposed new Longicorn beetle, described and figured by Herr A. F. Nonfried, of Rakonitz, Bohemia, under the name of *Callipogon friedländeri*, in the *Berl. Ent. Zeitschr.* 1892. He said that the supposed characters of the insect were due to the fact that the head had been gummed on upside down! He also exhibited an extensive collection of Coleoptera and Hemiptera-Heteroptera made by himself in the island of Corsica in May and June last.—The Rev. Theodore Wood exhibited a variety of *Saturnia carpini*, with semi-transparent wings, a large proportion of the scales being apparently absent, bred with several examples of the type-form at Baldock, Herts; also a pale variety of *Smerinthus populi*, which was said to have been bred, with several similar specimens, from larvæ marked with rows of red spots on both sides.—Mr. R. South exhibited a variety of *Argynnis aglaia*, approaching the form known as var. *charlotta*, and a variety of *Euchelia jacobeæ*, in which the crimson costal streak was continued along the outer margin almost to the inner margin, taken at Ringwood, Hants, in 1893; a variety of *Argynnis euphrosyne*, taken in Epping Forest in 1893; and a series of black and other forms of *Phigalia pedaria*, bred during the present year from a black female captured last spring.—Mr. H. Goss exhibited, for Mr. C. B. Taylor, of Jamaica, a beautifully coloured drawing of the larva of *Papilio homerus*.—Mr. F. W. Frohawk exhibited drawings showing the complete life-history of *Argynnis aglaia* and *A. adippe*, every stage being figured; also enlarged drawings of the segments of the larvæ in their first and last stages, showing the remarkable difference in structure.—Mr. G. C. Champion read a paper entitled "On the *Tenebrionidæ* collected in Australia and Tasmania by Mr. J. J. Walker, R.N., during the voyage of H.M.S. *Penguin*, with descriptions of new genera and species." Mr. J. J. Walker and Colonel Swinhoe made some remarks on the paper.—Mr. Champion also read a paper entitled "An Entomological Excursion to Corsica," in which he described an expedition to the mountains of that island in June, 1893, in company with Mr. Standen, Colonel Yerbury, R.A., Mr. Lemann, Mr. Raine, and others. Mr. Osbert Salvin, F.R.S., Colonel Yerbury, and Colonel Swinhoe took part in the discussion which ensued.—Mr. Edward Saunders communicated a paper entitled "A List of Hemiptera-Heteroptera collected by Mr. Champion in Corsica, with a description of one new species."—Mr. W. F. Kirby read a paper entitled "Notes on *Dorydium westwoodi*, Buchanan-White, with observations on the use of the name Dorydium."—Mr. Charles B. Taylor communicated a paper entitled "Description of the larva and pupa of *Papilio homerus*, Fab."

Zoological Society, March 6.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of February 1894.—Mr. W. Bateson exhibited and made remarks on a series of pilchards, the scales of which presented some remarkable variations. Mr. Bateson also gave an account of an abnormally coloured brill.—Dr. J. W. Gregory gave an account of the factors that appear to have influenced zoological distribution in East Africa, and made some suggestions as to how the present anomalies of animal life in that part of the continent might be accounted for. Dr. Gregory also exhibited and made remarks on a series of lantern-slides illustrative of his recent journey to Mount Kenya.—A communication was read from Prof. F. Jeffrey Bell, containing an account of examples of three species of river-crab of the genus *Thelphusa* from different districts of East Africa.—Mr. W. H. Adams read some notes on the habits of the flying squirrels of the Gold Coast belonging to the genus *Anomalurus*.—Mr. W. Bateson gave an account of two cases of colour-variation in flat-fishes, illustrative of the principles of symmetry.—A communication from Prof. P. R. Uhler, of Vienna, contained an account of the Hemiptera Heteroptera of Grenada, West Indies, based on specimens submitted to his examination by the committee for the exploration of the West Indies.—A communication was read from Mr. W. Schaus, containing descriptions of a large number of new species of moths from Tropical America.

PARIS.

Academy of Sciences, March 5.—M. Loewy in the chair.—Account of the scientific career of Admiral Mouchez, by M. O. Callandreau.—On Laplace's series, by M. H. Poincaré.—Preparation of a crystallised calcium carbide by means of the electric furnace; properties of this new body, by M. Henri Moissan. Pure lime is reduced by sugar charcoal in the electric furnace, $CaO + 3C = CaC_2 + CO$. The carbide forms a black crystalline mass, of sp. gr. 2·22. It reacts rapidly with water, producing pure acetylene. The properties of this carbide are given in great detail by the author.—Determination of the specific gravity of melted magnesia, by M. Henri Moissan. With a specimen of melted oxide of about 50 grams weight, a sp. gr. 3·654 has been reached.—Actinometric observations made at Montpellier Observatory in 1893, by M. Crova. A comparison of the average heat intensity with that at corresponding periods for the average of the preceding ten years is given, which shows clearly the great increase in the amount of

solar heat reaching the earth's surface during the months May–November.—Geodetical and astronomical survey work in Madagascar, by Father E. Colin.—On the abelian integrals which can be expressed by logarithms, by M. E. Goursat.—On the laws of the errors of situation of a point, by M. Maurice d'Ocagne.—On the distribution of deformations in metals subjected to stresses, by M. L. Hartmann. Several cases are considered, and the selective chemical action of acids on the lines of deformation of metals under the action of applied forces is noticed.—On the absorption of energy by an elastic thread, by M. Lucien de la Rive.—Production of sound in a microphone, under the action of an intermittent thermal radiation, by M. Eugène Semmola.—Experimental study on the expenditure of energy corresponding to the chemical action of light, by M. Georges Lemoine. The results show that in the case of the exothermic mixture of ferric chloride and normal oxalic acid, the ratio between the absorption corresponding to the molecular work and the total absorption does not exceed some ten-thousandths. Light seems to act only as an exciting agent in this reaction.—On exact atomic weights, determined with silver as secondary standard substance, by M. G. Hinrichs. An abstract of a discussion of some of the results of J. P. Cooke, Dumas, Stas, and others, wherein the author concludes that he has shown reason for regarding the following atomic weights: Cl 35·5, Br 80, I 127, and S 32, as correct if silver be taken as 108.—On alloys of iron and nickel, by M. F. Osmond. The initial temperature of the alloy and its speed of cooling have the same effect on its properties as in the case of irons containing the same carbon percentage, and are not of such importance as in the cases of hard steels and alloys of iron with tungsten and chromium.—Action of bromine on paraxylene, by M. J. Allain Le Canu.—On cinchonifine, by MM. E. Jungfleisch and E. Léger.—On the isomerism of the nitrobenzoic acids, by M. Oechsner de Coninck. A study of the solubilities of these compounds in dilute acetic acid, dilute hydrochloric acid, acetone, methyl alcohol, and 92 per cent. ethyl alcohol. Great similarity is shown between the ortho and meta acids as regards solubility, whereas the solubility of the para acid is much less.—On dibromogallanilide and its triacetyl derivative, by M. P. Cazeneuve.—Researches on the anatomy and development of the male genital armature of lepidoptera, by M. Peytoureau.—On the nervous system of *Dreissensia polymorpha*, by M. Toureng.—On certain active principles in the Papayaceæ, by M. Léon Guignard. The author shows that just as in the case of families nearly related to the Cruciferæ botanically, so here in a widely differing family the character and localisation of certain distinctive chemical principles resembles that obtaining in the Cruciferæ.—The sexual reproduction of Mucorini, by MM. P. A. Dangeard and Maurice Léger.—Symbiosis of *Heterodera radicicola* with plants cultivated in the Sahara, by MM. Paul Vuillemin and Emile Legrain.—On some minerals of New Caledonia, by M. A. Lacroix.

AMSTERDAM.

Royal Academy of Sciences, February 24.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Pekelharing commented upon a communication of Dr. Grijns, of Batavia, on the determination of the volume of blood corpuscles. In connection with Eykman's researches on the question whether the sojourn in tropical regions causes an alteration of the blood in Europeans, Dr. Grijns has developed a new method of determining the volume in question, and has also determined the influence upon it of different substances in watery solution. Defibrinated blood was subjected to a whirling motion in small calibrated tubes; the height of the layer of cruor was measured, the serum removed, the cruor mixed with the solution in question, and again whirled. The solution in which the height of the cruor was the same as in the serum, was isotonic. The concentration of the solutions of salt, cane-sugar, milk-sugar, oxalate of sodium, potassium chloride, asparagin, that leave unaltered the volume of the cruor, were really found to be in isotonic relation. Other substances—urea, ammonium-chloride, ammonium-nitrate, glycerine, alcohol—are in no concentration isotonic with the blood corpuscles. Potassium bichromate and corrosive sublimate affect the blood corpuscles considerably in each concentration. On these preliminary results the author has founded a new method for the determination of the volume of the blood corpuscles.—Prof. Bakhuyzen read a paper on the variation of latitude. He showed by discussing series of observations, made during the last thirty-five years at Greenwich, Washington, Pulkowa, Leyden, Berlin, Potsdam, Strasburg, and Prague, that a variation in a period of about 430 days, as determined by Mr. Chandler, was manifest; that there was no evidence of a change in the length of the period, and that its most probable value was found to be 430·7 days, while the resulting value for the coefficient was 0″·168.—Prof. Bakhuyzen also showed that the tidal observations, made at the Dutch station of Helder in the years 1855–92, indicated a marked variation of the sea-level in the same period with a coefficient of about 8 millimetres. Adopting the theory of Prof. Newcomb, based on the hypothesis that the earth is not absolutely rigid, the two results are in accordance with one another, and they seem to prove that the rigidity of the earth must be about 1·5 times as great as that of steel.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Ostwald's Klassiker der Exakten Wissenschaften, No. 44, 48–51 (Engelmann, Leipzig).—The Country Month by Month: J. A. Owen and Prof. Boulger (Bliss).—The History of Human Marriage: E. Westermarck 2nd edition (Macmillan)—Scottish Land-Names: Sir H. Maxwell (Blackwood).—Aphorisms from the Writings of Herbert Spencer (Chapman and Hall).—Principia Nova Astronomica: Dr. H. Pratt (Williams and Norgate).—Surveying and Surveying Instruments: G. A. T. Middleton (Whittaker).—Grundzüge einer Entwickelungsgeschichte der Pflanzenwalt Mitteleuropas: Dr. A. Schulz (Jena, Fischer).—Elementary Metal Work: C. G. Leland (Whittaker).—Smithsonian Institution Annual Report to July 1891 (Washington).

PAMPHLETS.—Report on the Coal-Measures of Blount Mountain: A. M. Gibson (Montgomery, Alabama).—The Problem of Man Flight: J. Means (Boston).—The Average Elevation of the United States: H. Gannett (Washington).—On the Astigmatism of Rowland's Concave Gratings: Dr. Sirks (Amsterdam, J. Müller).—Di Alcune Esperienze di Radiofonia: E. Semmola (Napoli).

SERIALS.—Seismological Journal of Japan, Vol. 2, 1893 (Yokohama).—Annaes de Sciencias Naturaes, No. 1 (Porto)—Medical Magazine, March (Southwood).—Illustrated Archæologist, March (C. J. Clark).—Internationales Archiv für Ethnographie, Band vii. Heft 1 (Leiden, Brill).—L'Anthropologie, tome v. No. 1 (Paris, Masson).—Himmel und Erde, March (Berlin, Paetel).—American Journal of Science, March (New Haven).—Journal of the Franklin Institute, March (Philadelphia).—Engineering Magazine, March (New York).—Psychological Review, No. 2 (Macmillan).

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