THURSDAY, AUGUST 26, 1886

THE PHYSIOLOGY OF PLANTS

Lectures on the Physiology of Plants. By S. H. Vines, M.A., D.Sc., F.R.S. (Cambridge University Press, 1886.)

IT has already been pointed out in the columns of NATURE that our botanical schools in England are at present leading in great measure a parasitic existence on those of Germany in respect of the text-books which are in common use: translations of the works of Prantl, Sachs, and De Bary are in the hands of most of our students, while the number of manuals from foreign sources will shortly be increased by the publication of others which are in active preparation. However greatly we may admire the works of the above authors, still it is with no small satisfaction that we turn from them to the review of a book which we may well regard as the first-fruits of a renaissance in this country of the physiological branch of the science of botany; and the more so as the production of original text-books may be taken as one important indication of activity in the pursuit of the subject to which they relate. But while receiving this work of Dr. Vines with a hearty welcome, it is to be regretted that, as noticed in the preface, a considerable interval of time has unavoidably elapsed between the printing of the first sheets and the completion of the book: thus one great advantage of original production as opposed to translation, viz. that of being more nearly up to date, is in some measure lost in the present case, and it is to be hoped that the book will, as it well deserves, quickly run on to a second edition in which this defect may be remedied.

Those who have had the advantage of hearing Dr. Vines in the lecture-room would expect from him a clear style, and a skilful arrangement of the matter; and these are two of the most prominent characteristics of the work before us. Its scope is not that of a manual for mere beginners; it is rather constructed to meet the requirements of advanced students, and accordingly the author is freed from the *impedimenta* of external morphology and anatomy, a sufficient knowledge of which he presumes to have been acquired from other sources. But notwithstanding this presumption, the introductory lectures open in a manner easily followed by the uninitiated, and the whole could be read with advantage by any one who has become acquainted with the mere rudiments of vegetable anatomy.

The first three lectures are devoted to the structure and properties of the vegetable cell, including the osmotic and optical characters of its parts; this is preparatory to the study of the absorption of water, of the substances in solution in it, and of gases, which occupies the two following lectures, this subject being followed in fitting sequence by a discussion of the movements of water in plants, and transpiration. Lecture VIII. is devoted to the constituents of the food of plants, together with the more salient points as regards the functions of the several elements, and the sources from which they are obtained; in this, as in other parts of the book, a short historical sketch is given of the development of knowledge and opinion regarding each several function. Then follows the subject of "metabolism" in its widest sense, a broad distinction being drawn between constructive metabolism, or the building up of the organised structures of plants, and destructive metabolism, or the conversion of more complex substances into others of simpler composition. It is in the treatment of the constructive metabolism that the most striking novelty will be found by English readers, in the introduction of a view regarding the formation of non-nitrogenous organic substance, which, though propounded some years ago in Germany, has now we believe, appeared for the first time in an English text-book. While allowing that starch is the first *visible* product of the constructive processes, the question is asked whether the starch which appears in the chlorophyll corpuscles of a green plant under the influence of sunlight is *directly* connected with the decomposition of carbon dioxide which goes on in them? The answer is as follows (p. 145):—". . . according to Schmitz and Strasburger and in harmony with the older statements of Pringsheim, the cell-wall is produced by the actual conversion of a layer of protoplasm, and we shall see hereafter that the same is asserted of the layers of the starch-grains found in seeds, tubers, &c. Translating this into chemical language we find it to mean that molecules of protoplasm may undergo dissociation in such a way as to give rise to molecules of carbohydrate among other products. The conclusion to be drawn is, that the starch which is formed in chlorophyll corpuscles under the influence of light is also the product of such a dissociation of protoplasm." . . . Both here, and more definitely on p. 158, this point is accepted as proved, and is repeatedly referred to in the treatment of constructive metabolism. But, it will be asked, is it at all admissible thus to "translate" microscopical observations into chemical language? When it is remembered that we do not yet know the constitution of the molecule of protoplasm, that the protoplasm of a living cell is confessedly a most complex mixture, and that the observations quoted demand powers approaching the limits of microscopic observation, it would appear that this "translation" is little more than a figure of speech; that the process is *probably* as Dr. Vines describes it many will be found to admit, but it cannot be allowed that the evidence adduced by him is even a near approach to demonstration. This is not the only case of accepting a probability as a proved fact; thus on p. 174 we read:—"Seedlings, it is well known, contain considerable quantities of amides, and the presence of these can only be accounted for by regarding them as having been derived from the reserve proteids of the seed. It is then in the form of amides that nitrogenous organic substance is supplied to the seedling."

English readers will have become familiar with the view of Pfeffer and Draper that it is the yellow rays of the spectrum which are most efficient in the process of assimilation; and it will be a new idea to many that the balance of experimental evidence is rather in favour of the view of Lommel and others, more recently supported by the observations of Engelmann, that those rays which are absorbed by chlorophyll, viz. the red and violet rays, are the chief source of the energy which becomes latent in the process of formation of organic substance in green plants.

It is impossible within the limits of a short notice to take up more than these two points, but they will be sufficient to indicate that the part of the book which treats of metabolism contains much that is new to English readers both in view and in observation. At its close (p. 326) the results acquired are summarised in tabular form, constructed so as to appeal to the eye as a balance sheet, which takes account of income and expenditure of matter and energy, first in green, and then in colourless plants; this brings out clearly the conclusion that there is a nett balance in favour of the plant in either case, of both matter and energy.

The next section of the book (Lectures XV.-XXI.) opens with a description of the fundamental phenomena of growth, which is a clear statement of facts for the most part already familiar. This leads to a discussion, extending over four lectures, of the accompanying phenomena of irritability of growing organs, which result in their varied directive curvatures; two further lectures are devoted to the irritability of mature organs, considered in the light of the observations of Gardiner and others on the continuity of protoplasm; and the book closes with three lectures on reproduction; these include first an account of the chief types of both sexual and vegetative reproduction, and conclude with a discussion of the theories of sexuality of Strasburger, Naegeli, and Weismann.

With regard to the use of terms, two points demand notice: first, as to the words "dorsal" and "ventral," which have so often been the subject of discussion, especially because of the ambiguity arising from their different mode of application to leaves, and to dorsiventral shoots. But is it necessary to use the terms at all as applied to leaves? Will not the terms "anterior" and "posterior" convey the idea just as well, the terms "dorsal" and "ventral" being thus left free for application to dorsiventral shoots? Secondly, Dr. Vines has not accepted the term "zygote" proposed by Dr. Strasburger as generally applicable to the fertilised ovum: this term is of use in avoiding the terms "zygospore" and "oospore," which, especially the latter, are often understood in an ambiguous sense.

To say that Dr. Vines's book is a most valuable addition to our own botanical literature is but a narrow meed of praise: it is a work which will take its place as cosmopolitan; no more clear and concise discussion of the difficult chemistry of metabolism in the plant has appeared, while the part which treats of irritability is an able digest of the voluminous, one might almost say inflated, literature on this branch of the science. In estimating the value of the book as a whole, we must bear in mind the circumstances in which physiological botany is at present placed. There is no branch of biological science upon which it is more difficult to write; our position with regard to the phenomena of vegetable life is throughout based rather upon a calculation of probabilities than upon clearly established facts; it is for each individual teacher in the exercise of his duty to draw a line between the discussion of views, and the acceptance for teaching purposes of points still *sub judice* as though they were established truths. Dr. Vines has gone rather further in the acceptance of probabilities than some will be prepared to follow him, and it is perhaps to be regretted that this should be the case in a book intended for the advanced rather than the elementary student. Placing this on one side, the book is one which must command admiration; a glance at the lists of references at the end of each lecture will give a clue to the extent of the literature which has been searched through; in erudition it stands alone among English books on the subject, and will compare favourably with any foreign competitors.

F. O. B.

A PLEA FOR THE RAIN-BAND

A Plea for the Rain-Band, and the Rain-Band Vindicated. By J. Rand Capron, F.R.A.S., and F.R.Met.S. (London: Edward Stanford, 1886.)

A NEAT little spectroscopic book, and furnished, as all such books should be, with a nice index, as well as not a few plates, which may be considered a second, or graphical, index of an instantaneous reference kind. But further it is both an honest, and a modest, production; for while it says nothing more on its title-page than what it fulfils, it has not cared to introduce there a compliment which it might have most legitimately claimed.

How often in literary history have not two words decided whether a book shall be bought and read, or not: these words being "second edition." But here they might have been exchanged for third, if not even fourth, edition, or "issue" at all events, for the date January 1886.

Mr. Rand Capron is evidently of a very practical order, and writes for practical men; and as he writes only of what he fully understands, and has abundantly worked at with his own eyes and hands,—he has the faculty of pleasing and satisfying those whom he addresses. This is testified to most particularly by the successive reprints of his first pamphlet within the short interval of five years; for though he was not the first and earliest rain-band writer, a public had to be created for the subject, and is evidently now rapidly increasing. This too notwithstanding that the feature wherein Mr. Capron's book is very strong, viz. numerical comparison of rain-band indications in the spectroscope, step by step with rain-gauge measures, or ozone papers, or hygrometrical readings of wet, and dry, bulb thermometers, forms by no means a smooth and easy-flowing kind of reading, as mere reading; however instructive it may be, and even necessary to have at hand to confront unreasoning objectors of an older school; endued often with imperfect senses, but all the more positive in their denunciations of a new departure in meteorology, on that very account.

If the poet is born, and is not to be manufactured by the tutors known in these days of cram as "coaches," so is it most assuredly with spectroscopic observers, when the subject to be observed is not the angular place of a sharp line, but the degree of intensity of a nebulous band of shade like the rain-band. Such intensity too to be determined, not by long and repeated observations with some grand photometrical apparatus mounted on a firm altazimuth stand, with tangent screw motions in every direction, but by a moment's look through a mere waistcoat pocket gem of an instrument held lightly between thumb and finger, and leading instantly to a judgment on the case, like a stroke of nothing less than pure genius.

Yet, by the marvellous aid of the prism with a narrow slit in front of it, there appear to be every year more and more persons who can accomplish the feat, and feel extraordinary satisfaction, even exhilaration, in the act of so doing. Wherefore after reading Mr. Capron's earlier pages, laying down what the rain-band, as seen in the spectroscope, really is, how it is to be observed, recorded, and concluded upon, the percentage of its correctness, and the kind of assistance it may afford to other methods of weather prediction in meteorology,—we have had still more pleasure in coming to his Part II., on "The Rain-Band Vindicated." For therein he describes succinctly the contests which have been recently going on in the meteorological world on the subject, and the rise of many new authors, either bringing in most varied experiences to show the truth of the principle, or still better publishing extensions of it. While from one of Professor Sir Henry Roscoe's earliest works on spectroscopy in general, and the telluric additions to the lines of the solar spectrum in particular,—is extracted this paragraph, which deserves to live.

"No one can tell what secrets lie hid in these atmospheric lines, but to us it seems that by their careful and systematic observation, 'the Message from the Stars' which has taught us so much, may be rivalled in practical importance by a 'Message from the Sky.'"

And the harvest to be gathered is still on the increase; for since the appearance of Mr. Capron's last edition, a new observer in unusually exalted circumstances of temperature, sunshine, and moisture (viz. Mr. Maxwell Hall, in Jamaica), almost at once discovered another rain-band, not in the red, but in the green of the spectrum; and as super-excellent for prediction-use in that tropical island, as our D rain-band in the red is to ourselves at home. What wonder, then, that so able a physicist and astronomer writes, and with such hope and joy too of soon having more leisure to devote to science,—writes, we repeat, that although he has not yet settled the exact line of research he will devote himself to,—it must be "something spectroscopic."

Notwithstanding too that, as yet, the rain-band spectroscope has only been employed by day, in noting the dark, or so-called Fraunhofer, lines and bands on the bright continuous spectrum of the sun-illumined clouds or sky,—there seems a new utilisation of it opening up in detecting aurora, when otherwise invisible, by its unique bright citron line in a dark field at night; and thereby affording men another kind of rainfall prediction, even so much as forty-eight hours beforehand.

In conclusion, though not exactly touching on rain-band, we should call attention to Mr. Capron's appendix, descriptive of his well-arranged and successfully carried out observations on atmospheric electricity, as likely to lead eventually to something practical and exceedingly important. For, as M. Gaston Planté has long held in Paris, he has never yet known a storm of wind which was not accompanied by measurable disturbances of electricity; and with indications that the whole quantity of that fluid, lying latent in the earth, is a store of almost unimaginably large quantity, derived from the Creation Age, and only very slowly escaping; while man is still merely looking on, and unable to turn it to any useful account.

C. P. S.

OUR BOOK SHELF

A Manual of Surgery. In Treatises by various Authors. 3 vols. Edited by Frederick Treves, F.R.C.S. (London: Cassell and Co., 1886.)

MESSRS. CASSELL, in issuing these volumes among their manuals for students of medicine, did wisely in invoking the aid of some thirty hospital surgeons, who have in these three handy volumes produced a very practical work of high excellence.

In comparing such a work as the present with a book on surgery written fifteen or even ten years ago, we are at once struck, on the one hand, by the number of new operations which have been introduced, mainly owing to antiseptic surgery; and, on the other, by the much greater definiteness and accuracy with which diseases and lesions are defined and differentiated from one another. As a consequence, the material is so extensive in amount that operative surgery and pathology will occupy additional volumes.

The relations of micro-organisms to septicæmia, pyæmia, and the treatment of wounds, receive full discussion, extending over several chapters. There is a valuable chapter by Mr. Mills, Anæsthetist to St. Bartholomew's Hospital, on the production of anæsthesia and the means of dealing with the difficulties that may occur.

In the discussion of knee-joint disease a much more favourable view of the benefit of rest is taken than would accord with our experience, and it is stated that with the application of splints the great majority of cases will end in complete recovery in six to nine months. This result, however, is surely uncommon, and too often the pulpy mischief progresses until, after months or years of rest, the patient is able to get about again with a limb liable to lay him up after the slightest exertion, or it has ultimately to be amputated. On the other hand, the permanent good results which are obtained by excision of the knee are much under-estimated, and, instead of falling more and more into disuse, the operation will in the future often be the means of saving limbs that are now amputated, especially when the excellent results that can be shown for a long series of cases have been published.

Abdominal surgery receives ample notice, and in no department during the last ten years has greater progress been made; many injuries and diseases which were formerly necessarily fatal are now amenable to operation. Continental surgeons, able to perform trial operations on animals, are far more successful in their operations on the intestines than we are, and every year human lives are offered up as a holocaust to the fanaticism of the anti-vivisectionists. It is to the physiologists that we are indebted for the elaboration of the various steps by which success is now achieved both in these operations and in those on the brain.

The general excellence of the illustrations, which number 200, is worthy of note; and while many are original, not a few have been selected from other books. There is no doubt that each year it becomes more easy to obtain typical illustrations of disease. We would therefore take exception to the illustrations of the teeth of congenital syphilis, of myxœdema, and of single hare-lip, of which more characteristic examples might have been taken.

The handy form of the volumes, as well as the practical nature of the book, will insure its popularity among students.

L'Évolution et la Vie. Par Denys Cochin. (Paris: Masson, 1886.)

This work, which is a *réchauffé* of the ordinary facts of digestion as given in the text-books, and of the relations of micro-organisms to vital processes, and more especially of Pasteur's work on the subject, must have been written chiefly for the author's amusement. It opens with a protest against Herbert Spencer's application of the principles of evolution to the solution of vital, social, and mental problems. The author then proceeds to set up a ghost founded on the statement made some years ago, that "there is no evolution without spontaneous generation." To refute the theory of spontaneous generation will be, he says, to give a direct blow to the theory of evolution. This, he maintains, has been amply done by Pasteur and others, and a number of the most important experiments are here referred to.

The author proceeds to argue that, since evolution has failed to explain the first beginnings of life, there must have been a God who created matter, a living germ, and an intelligent mind, and that the three creations were distinct.

He gives a clear account of many of the vital as distinct from the non-vital processes, and draws especial attention to the fact that solutions of many of the higher organised products polarise light, and that the only organic bodies which have been formed synthetically are the lower organised products which do not polarise light. It is doubtful, however, whether the distinction is one which will hold much longer, as chemical methods are constantly improving.

The author adduces no new facts, but he has the merit of bringing together in a very readable form, statements more or less scattered about in several books and periodicals.

History of the Royal College of Surgeons in Ireland, &c. By Sir Chas. A. Cameron. (Dublin: Fannin and Co., 1886.)

THIS volume, which is published at the expense and by the authority of the College of Surgeons, collects together the charters and histories of the various Irish Medical Schools and Colleges, and supplies biographies of the leading members of the medical profession in Ireland, together with a list of their works.

Many curious ana are given of the old physicians; among others, of Joseph Rogers (1734), one of the first to feed fevers, who gave a patient daily for a month four to six quarts of sack-whey and two quarts of mulled canary, which was certainly vigorous treatment.

The first Society for the regulation of medicine in Ireland dates back to 1446, when Henry VI. established a Guild of Barbers in Dublin; and later on, in 1572, Queen Elizabeth granted a new charter by which women were admissible to the guild; and in those days a barber was equivalent to our surgeon. This Society lingered on until the foundation of the College of Surgeons in 1784.

This book will be of great use as a work of reference with regard to the state of medicine at any period in Ireland, and its compilation must have been a laborious labour of love on the part of the author. The biographies, which are very numerous, form the most interesting part of the work, and include a large number of world-renowned names, the greatest of which are probably Graves and Stokes.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Physiological Selection and the Origin of Species

As I was unable to be present at the Linnean Society when Mr. Romanes read his paper on the above subject, I may take the opportunity furnished by the publication of the abstract in these columns to put forward certain views which I have long held with reference to the points raised by the author. I may remark that I am writing under the disadvantage of distance from notes or books of reference, and that I have not yet seen the complete paper. Moreover, my work of late years has run off biological tracks, and I can but regret that my remarks must, under the present circumstances, be of a more or less general character; but at any rate they may be of use as a contribution to the discussion which Mr. Romanes' carefully considered paper well merits at the hands of biologists.

In the first place, I should like to point out that evolution by what Mr. Romanes calls "independent variation," or the prevention of crossing with parent forms, is very ably discussed by Weismann in one of his earlier works, "Ueber den Einfluss der Isolirung auf der Artbildung" (1872), which essay I can commend to the notice of all interested in the subject. Weismann termed this principle "*Amixie*," and for want of a better word I have rendered this "Amixia" in my edition of the "Studies in the Theory of Descent," in which work the principle is also frequently alluded to.

All evolutionists will agree with Mr. Romanes that natural selection *per se* is incompetent to account for the origin of species. This has long been admitted by naturalists, and Darwin himself in later life frankly acknowledged that in the early editions of the "Origin of Species" he over-estimated the power of this agency. Nevertheless, Darwin to the last considered natural selection as the *chief agency* in the evolution of species, and no one saw more clearly than he did the difficulties which surrounded the formation of incipient species, owing to the obliteration of new characters by intercrossing with the parent form. The sterility of natural species as compared with the fertility of domesticated races is also a difficulty which Darwin fully recognised and did much towards meeting. The results of his investigations in this direction have been to break down the supposed fixity of the rule, although it must be admitted that the broad fact still remains, and we cannot but be grateful to Mr. Romanes for once more emphasising this difficulty with his characteristic clearness. It is chiefly—if not entirely—with the object of meeting this difficulty that "physiological selection" has been conceived, because, as it appears to me, the other difficulties referred to by Mr. Romanes, viz. those connected with the prevention of intercrossing and the inutility of trivial characters, are quite subordinate to this main difficulty, and need not be further considered until the admissibility (or otherwise) of physiological selection has been settled. The questions now to be decided are whether natural selection + sexual selection + correlated variability + amixia + use and disuse, &c., is really a theory of the origin of *species*, or whether these factors have been only made to "pose" as such? Is "physiological selection" competent to account for the origin of species?

If I interpret Mr. Romanes correctly, his theory is equivalent to the admission that amixia may become inter-racial, *i.e.* that it may arise among the individuals of a species without the intervention of physical barriers by the spontaneous origination of a physiological barrier, *i.e.* by variation in the reproductive capacity. That such a form of variation may exist I have long been willing to admit, and I do so now with all the more readiness in face of the arguments so skilfully marshalled by the author of the new theory. But, since Mr. Romanes admits the efficiency of natural selection, the question seems to resolve itself into this: Can physiological selection work independently of natural selection? If not, natural selection must still be regarded as a prime factor, and if physiological selection cannot originate a species independently of the control of natural selection, surely the latter, with its subordinate factors (of which physiological selection *may be* one), is still *the* chief element in the theory of the origin of species.

Let us suppose, for the sake of argument, that among the individuals of a species there arise certain varieties which are fertile *inter se*, but sterile with the parent form. There would thus arise a new race which could not be swamped by intercrossing with the predominant form, and the one species would practically be resolved into two—the parent form being still in the ascendency as regards numbers. But the competition is always most severe between the most closely related forms, and unless the new form (arising by inter-racial amixia) possessed some distinct advantage over the old one, it would as surely be exterminated by the overwhelming majority of the parent type as it would be by intercrossing in the absence of amixia. Physiological selection thus appears to me to be as subordinate to natural selection as sexual selection, correlated variability, the law of homology, or any other of the Darwinian factors. The expression used by Mr. Romanes for his new factor—the "Segregation of the Fit"—seems to imply fitness for something, presumably for the conditions of life, and if the survival of the "fit" race is determined by natural selection, then I venture to think that natural selection must still be regarded as *the* theory of the origin of species and as something more than a theory of the origin of adaptations.

To the foregoing Mr. Romanes will probably say that physiological selection is a *necessary* adjunct of natural selection, and that no new species can arise without the co-operation of his factor. If this be the case, then, bearing in mind the views which I have expressed with reference to the subordination of physiological to natural selection, it seems to me that the most likely course to pursue is to appeal to the latter for an explanation of the "primary" specific character, viz. sterility. It is true that Darwin and many of his followers have attempted in vain to account for this primary specific distinction by natural selection, but I still venture to think that the solution lies in this direction. Indeed, the elements of the solution appear to me to be furnished by the original theory of Darwin and Wallace, as I will now briefly attempt to show, hoping to elaborate the idea on some future occasion, or, still better, leaving it for development or extermination in the hands of professed biologists.

The struggle for life being the most severe between the most closely allied forms, diversity is in itself an advantage, because the individuals which depart from the parent type may (but not necessarily *must*) "seize on many and widely diversified places in the economy of nature, and so be enabled to increase in numbers." Hence Darwin's principle of "divergence of character," so well restated by Mr. Romanes in his paper. Now, if diversity is an advantage, natural selection can deal with it like any other advantageous character, and *would seize upon any means afforded to secure its perpetuation*, provided always that the divergence was in the direction of some unoccupied "place in the economy of nature." This last condition amounts to nothing more than that the divergence is to be of an advantageous character. Among the most effectual means of securing permanent diversity must be sterility with the parent form: hence, given a variability in the reproductive capacities of different pairs of individuals (which I have already conceded), the question is whether natural selection could not develop out of this more or less imperfect fertility a more or less complete sterility. If it is to the advantage of some particular variety not to resemble its parent form, out of the immense number of divergences which are always taking place (by ordinary variation) those varieties which showed the greatest infertility with the parent form would in the long run survive, for the very reason that their progeny, tending to inherit the characters of their parents, would possess the advantageous characters of the latter, which led to their survival in the first instance, and, among these characters, that diminished fertility with the parent form which lessens the chance of their extermination by intercrossing.

As the foregoing argument is necessarily expressed in general terms, it will be of use to specialise our ideas by an appeal to a hypothetical case. Suppose, for instance, that a dominant species gives rise to the twelve varieties A, B, C, ... L, out of which four, B, D, K, L, possess some slight advantage over the parent form, adapting them to some new conditions in their environment. The four varieties thus stand a chance of surviving, while the eight others would be the "unfit." Now these four varieties in their incipient stage (and in the absence of isolation) would be subject to extermination by intercrossing in the next generation with the parent form. But the chances against these four varieties being *equally fertile* with the parent form must be exceedingly great: let us suppose, therefore, that B and K are less fertile with the parent form than D and L. Under these circumstances the latter would be wiped out by intercrossing, while the former would tend to retain their peculiarities and thus survive. The peculiarities both of B, K, and D, L, were originally advantageous, but those of B, K, are alone allowed to survive. The parent species has, as it were, attempted to give rise to four derived species, and has only succeeded in producing two. It is a case of selecting out of a number of advantageous modifications those particular varieties which are the least fertile with the parent form. From the slight sterility thus produced in the initial stages, natural selection, by acting in the same direction, might evolve the more or less perfect sterility which we now behold, because every departure on the part of the derived form in the direction of fertility with the parent form would be a retrograde step tending to obliterate those advantageous characters which led to the first survival of the new form, and the descendants of such partially fertile departures would constantly be weeded out owing to the dilution of their peculiarities with the less advantageous characters of the parent form. To put the case in another way, it may be said that natural selection is constantly endeavouring to develop the most advantageous modifications of every species, but succeeds the better the less the degree of fertility of the advantageous modification with the parent form, and succeeds only perfectly by producing perfect sterility with the parent form. Fertile advantageous modifications, on the other hand, would be swamped by absorption into the parent form.

I thus venture to think that the theory of natural selection as sketched out by Darwin and Wallace is still a theory of the origin of species. The production of the sterility of species by this agency is, according to the present views, to be referred to the same causes as all the other modifications produced thereby, viz. the natural selection of a "spontaneously" occurring variation in the function of one particular organ. In the case of domesticated races no such selection with reference to the functions of the reproductive system has been effected, but the varieties have only been kept from interbreeding by what amounts to isolation. It is not surprising, therefore, that such artificial forms, which have been selected only with reference to *external characters*, should be fertile *inter se*, while natural species, in which fertility *inter se* has been rigorously suppressed by natural selection through long series of generations, should exhibit a greater or less degree of sterility.[1] In other words, "physiological" appears as one particular phase of natural selection, and as far as we can see there is no reason why there should not be other modes of variation leading to the same result by acting indirectly upon the reproductive system. But all such modes of variation would still be subject to development or suppression by natural selection. R. MELDOLA

Greenock, August 21

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THE Duke of Argyll's letter about organic evolution, published in your last week's issue (p. 335), calls for a few remarks, as it is very misleading, and bespeaks some misconceptions on the part of the writer. He has evidently read his own views into the two articles on organic evolution contributed by Spencer to the April and May numbers of the *Nineteenth Century*. In those articles Spencer makes no "admission"; what he says there with respect to natural selection has been held by him for the last twenty-six years. He does not deny that the natural operations denoted by natural selection do constitute an operating cause in the evolution of species. Only, he goes deeper: he, with his characteristic truly philosophic insight, sees in natural selection a *proximate* cause; sees behind it the primordial operations of forces of nature which rendered natural selection possible, and supplied it with a *point-d'appui*. Then he assigns use and disuse as another cause in the origination of species. Now all this is not a "declaration against" what your correspondent pleases to call "Mechanical Philosophy," but is a part and parcel of it. It is rather a "declaration against" all sorts of teleological philosophy. Let him remember also that Spencer's philosophy is the acknowledged philosophy of evolution; and he may rest assured that, even if the theory of natural selection *as a cause* in the genesis of species be proved untrue, that philosophy will still stand opposed to any philosophy that will attempt to bring back "Mind" as one of the *causes* of organic evolution.

Your correspondent is a little too hasty in his rejoicings over Mr. Romanes' paper on "Physiological Selection." He will see from the second part of the paper that even Mr. Romanes is unable to deny that in some cases at least natural selection is quite competent to originate species.

Then your correspondent thinks the theory of natural selection "not only essentially faulty and incomplete, but fundamentally erroneous," "in so far as it assumes variations to arise by accident." Now by "accident" or "chance" in this connection, evolutionists (including Darwin) have simply meant the action

[1] From the above it follows that local races or species produced by isolation should be more or less fertile with the parent form. This is a point which might well be tested experimentally.

of some hidden physical causes whose exact mode of operation is not known. We all know, however, that variations are *facts* of nature, and it is not difficult to see that they are the necessary consequences of the varying number, amount, proportion, and manner of action, of the natural forces acting on different portions of living matter. Now, in making variations the starting-point, the theory of natural selection may justly be considered to be "incomplete," even as our knowledge of electricity is incomplete because we do not know the real nature of the thing, as astronomy is incomplete because we do not know for certain how, for instance, the solar system was formed; but in so doing the theory cannot be "essentially faulty" or "fundamentally erroneous." It is illogical, not to say childish, to think a theory to be erroneous because it cannot render a definite explanation of some unquestionable facts of nature on which it is based and with which it starts. To prove the theory of natural selection to be erroneous, it must be shown that it is never competent to originate species. If it ever falls, it will fall quite *ir*respectively of its avowed inability to give definite explanations as to the exact mode of occurrence of variations. S. B. MITRA

19, Keppel Street, Russell Square, London, August 17

Red Sunsets and Volcanic Eruptions

PROF. S. NEWCOMB's article on the above subject in NATURE of August 12 (p. 340) induces me to send you a brief account of the atmospheric phenomena that I observed in Palermo during and after the recent eruption of Mount Etna.

This volcano is 133 kilometres distant from Palermo, but the transparency of the air here is so great that it is almost always visible from this Observatory.

At dawn on May 21 the smoke from the eruption appeared as a great mass of black vapour, rising from the southern side of the volcano. At 11 a.m. it had formed into rosy balls of vapour, or cumuli. With the theodolite I measured the angular height—2° 21′, which gives 8 kilometres of linear altitude. On May 24 the smoke had the characteristic form of a pine-tree, and a greater height, but at 4 p.m. the upper edge of it was not well defined, and I obtained (approximately) the altitude as 14 kilometres.

Since May 22 these vapours from Etna have spread over the eastern, and more recently over the entire, horizon of Palermo. In the early morning of June 3 the fog was so dense that the sun was invisible, and the towers of the Matrice, 200 metres distant, were only indistinctly visible, which in Palermo is quite extraordinary. From May 29 to June 3 Italy has been invaded from south to north with mist, which was probably also derived from Etna.

Cinders from the volcano have fallen over Eastern and Southern Sicily, and over Calabria, as well as in Palermo, where, in the dust gathered on the terraces of the Observatory on May 27, I detected with the microscope some minute crystalline laminæ of labradorite, which mineral is characteristic of the ejections of Etna.

The sun rising from the sea behind these mists has been purple-red and then reddish-yellow; at a height of about 30° it was neutral gray, but never green or blue. In Nicolosi, too, on the side of the volcano, these colours of the sun have not been observed. The light of the red sun was so faint that it was possible to look at it without inconvenience.

No corona (like "Bishop's ring") was observed around the sun or moon. Spectroscopic observations of the red sun gave only the ordinary atmospheric absorptions, perhaps somewhat intensified.

In the latter part of May and during the month of June the red after-glows appeared almost daily, and were stronger than before or since, but they were not so brilliant and prolonged as in 1831 and 1883-84, and their colour was not properly rosy, but an impure reddish-yellow.

I believe that the red sun was caused by the finest cinders from the volcano, suspended in the air, as the like phenomenon is produced by the dust of the Höherauch in Northern Europe, of the Sirocco in Sicily, and of the Kamsin in Africa. The blue sun (observed after the eruptions of Ferdinandea and of Krakatão) has not appeared, and the after-glows were not strongly brilliant, because the vapours ejected from Etna were not so enormously abundant as those ejected from Ferdinandea and Krakatão, which are marine volcanoes more directly communicating with the water of the sea.

The observation by M. Janssen, mentioned in NATURE of July 29 (p. 299), of a blood-red coloration of light traversing dust, gives a strong confirmation to the preceding explanation of the red sun. A. RICCO

Palermo Observatory, August 17

P.S.—Since July Bishop's ring has not been visible in Palermo.

The Bright Clouds and the Aurora

ON the morning of the 11th inst. I had an opportunity of watching the curious cirrus-like clouds as daylight came on. The display was striking, though not such a bright one as on several former occasions. It first appeared about 2.30 a.m., when there were very faint indications of the clouds; it was some minutes before I noticed that they were the same brilliant kind as has appeared so often this summer. Their apparent upper border being irregular, it was uncertain whether they in any part reached the limit to which the sun could shine upon them, or whether the apparent border was altogether the actual edge of the cloud-sheet; however, it rose higher as the sun approached the horizon, but this might be owing to the circumstance that the motion of the clouds was, as usual, from an easterly direction. At 3.33½ a.m. they were visible as far as α Andromedæ, though they were very faint west of γ. By 3.45½ a.m. they reached down to within 5° of α Aquilæ, and were rather plain there, and by this time the sheet covered most of the sky, though none of it remained visible very low down in the east. It was no longer bright in any part. At 3.55½ they reached down to within 4° of α Aquilæ, and were plainest about there, but growing fainter. I was still uncertain whether the sheet extended beyond the western apparent border, that being simply the limit of sunshine, or whether the sheet ended there; but probably the former was now the case. At 4 a.m. they were scarcely noticeable, and by 4.11 they had disappeared altogether. By this time a faint pink glow had appeared in the east.

The question is, Was the disappearance of the clouds due to their having evaporated, and ceased to exist, or to their light being overpowered by the brightness of the sky? It appeared to me that the latter was the case. It will be well if further observers can confirm this supposition or otherwise; if correct, they cannot be considered clouds at all in the ordinary sense, the sky being beautifully clear and blue after they had ceased to be visible. I could not say at any time that the clouds were not perfectly transparent to the stars. The circumstance that they have never been described as having been seen by day seems confirmatory of the above supposition.

With respect to Prof. Smyth's remark about the spectrum (p. 311) I do not gather whether he considers that the auroral line noticed by him belonged at all to the clouds or entirely to the aurora; but I think that there can be no doubt that the latter was really the case. He does not seem to have detected any aurora at the spot where the clouds were seen, but doubtless it was there, although overpowered by their brightness. As it is so evident that these clouds were illuminated by the sun (this being confirmed by their varied colours depending on their altitude, as described by Prof. Smyth), we cannot expect their spectrum to be otherwise than solar and atmospheric. I looked at them with a miniature spectroscope on the evening of July 12, as well as on the morning of the 11th inst., but on neither occasion was the spectrum bright enough for me to perceive much. I could not see any lines, bright or dark, but the spectrum faded very abruptly in passing from green to orange, which no doubt was owing to the atmospheric bands near D, especially the "low sun band."

On July 27 I saw the aurora mentioned by Prof. Smyth at Gilsland, in Cumberland, and it was a particularly magnificent one there, especially about 10.25 p.m., at which time a part of it was lilac—a very unusual colour. The bright clouds were also visible that night, but chiefly before the aurora appeared and after it vanished; there appears no reason to suppose there is any connection between the two phenomena.

As regards the dark space beneath the auroral arch, has the theory mentioned by Prof. Smyth ever been proved, that there is any true darkness there, and that it is not merely the effect of contrast with the aurora? My impression is that it must be at least mainly the effect of contrast, though perhaps not entirely, and the idea is confirmed by a similar darkness sometimes appearing by contrast with the brilliant clouds, when no aurora is present; the stars shine quite bright in this dark sky above them.

Prof. Smyth considers that the night after the aurora of the 27th the twilight extended over the region "aurora-blackened" the evening before. Would not this be owing to the brightness of the aurora preventing the twilight from being seen so high then simply by contrast? The fact that the dark sky was luminous in the spectroscope seems to bear out this.

I do not understand Prof. Smyth's suggestion why these clouds should never be seen in winter, for any night in the year there is a time when the sun is at the same distance below the horizon as it is when the bright clouds are well seen.

Sunderland, August 18 T. W. BACKHOUSE

Cloud Effect

A VERY unusual cloud effect was noticed here on the 18th inst. at 7.45 a.m. The whole sky, especially to the east or south-east, was at that time covered with a widespread field of mackerel cloud. This field was cut from north to south with a strongly defined cleft or narrow line showing the blue sky beneath. It was like a crack in the cloudy tissue, and formed a perfect arch, whose greatest altitude was not many degrees above the sun's apparent place. It lasted nearly half an hour. There was little wind at the time, only a slow motion from the north, but a change took place shortly after, when it veered to the south-west. E. BROWN

Further Barton, Cirencester, August 20

The Crag Deposits on the North Downs

To students of Tertiary geology, the interest of Mr. Clement Reid's verification of Prof. Prestwich's judgment of many years ago as to the Pliocene age of certain outlying deposits at Lenham is so great that I must crave permission for space for a line or two with reference to other similarly situated deposits on the North Downs, which have been described as belonging to an horizon "somewhere between the Chalk and the moon." The deposits to which I refer were described by Prof. Prestwich in the *Q.J.G.S.*, vol. xiv., and of his paper Mr. Whitaker made free use in preparing the account of these outliers in vol. iv. of the "Memoirs of the Geological Survey" (pp. 336-42). The idea has been for some time growing up in my own mind, with reference to these unfossiliferous outliers, that some of them will have to be recognised as remnants of the once more widely extended Upper Bagshot Sands. This conclusion is at present based mainly on three facts: (1) the literal application of Prof. Prestwich's description of their lithological character to portions of those beds; (2) the occurrence of "similar beds on the Chalk Downs on the opposite side of the Channel, between Calais and Boulogne"; (3) the superposition of "analogous strata" on the top of Cassell Hill in French Flanders upon the *Calcaire grossier* series, the equivalent of our Middle Bagshot (so-called Bracklesham) Beds. I hope to deal with this more at length during the next session of the Geological Society, and only draw attention now to the suggestion which I threw out several years ago (*Proceedings* of the Geological Association, vol. viii. p. 170) for reasons assigned, that the oldest plateau-gravels of the London Basin are probably of Pliocene age. This may possibly have escaped Mr. C. Reid's notice. A. IRVING

Wellington College, Berks, August 17

Actinotrocha on the British Coasts

IN answer to Mr. Cunningham's letter on the distribution of Tornaria and Actinotrocha, I may state that I took Actinotrocha in the tow-net at the mouth of this bay on July 31. I believe I have found it more than once before on the west coast during the last few years, but, not having my note-books with me, I cannot say definitely where and when. If I am not mistaken, *Phoronis* was found by Dr. Strethill Wright in the Firth of Forth, and is therefore known as a British animal.

Loch Ranza, Arran, August 21 W. A. HERDMAN

GEORGE BUSK, F.R.S.

A SINGLE-MINDED, true-hearted man, a warm friend, and an able and accomplished naturalist, has just passed away from the midst of his family, his friends, and his fellow-workers.

George Busk was the second son of Mr. Robert Busk, of St. Petersburg. He was born in 1807, and at an early age gave promise of those tastes and of that aptitude for research which, developing with his years, gained for him the high position which he was destined to hold among the scientific workers of his time.

After completing his medical education he was appointed surgeon to the seamen's hospital-ship *Dreadnought*, a post which he continued to hold for about twenty-five years. It is these twenty-five years which constitute the strictly professional period of his life, and which gained for him a place among the most distinguished members of his profession as an able, clear-sighted, and enlightened surgeon.

In 1856 he resigned his appointment to the *Dreadnought*, and at the same time decided on retiring from professional practice and on devoting himself to scientific work.

Having now leisure for the cultivation of those studies which were always dear to him, he threw himself warmly into biological work. An excellent and cautious observer, it was chiefly to researches on the structure of the lower members of the organic world that he now devoted himself, and scarcely a month passed without the periodical literature of biology receiving from his labours the record of some new and interesting fact.

About this time he became one of the editors of the *Microscopical Journal*, and the numerous communications which appeared from his pen in the pages of that periodical contributed largely to its popularity and success.

There were few departments of biological science which Busk did not enrich by his researches, and we now find following one another in rapid succession a long series of papers containing the results of his studies among the lower groups of the animal and vegetable kingdoms. He was a skilful microscopist, an acute and conscientious interpreter of the optical expressions of organic form presented by the microscope to the observer, and his contributions to the transactions of our leading scientific societies and to various natural history journals have advanced our knowledge of some of the simple unicellular plants, of the Infusoria, the Hydroida, the lower Vermes, and above all of the Polyzoa, to an extent which those who have worked in the same fields can fully appreciate.

In 1856 appeared his article "Polyzoa" in the English Cyclopædia. In this admirable article we have an exhaustive account of the structure of the Polyzoa, while it contains the first satisfactory attempt at a scientific arrangement of the group, and proposes for the first time the employment of certain systematic characters which are now universally accepted as offering the only legitimate bases of a philosophical classification.

Soon after this he undertook the labour of drawing up an illustrated descriptive catalogue of the Polyzoa contained in the collection of the British Museum, and brought to bear on the descriptions and systematic arrangement of the species those principles whose soundness he had already established. There was thus placed in the hands of the student a work of great value, with which no investigator of the group can afford to dispense.

On the return of H.M.S. *Rattlesnake* from its explorations in the Australian seas under Capt. Owen Stanley, the collections of Polyzoa and Hydroids made during the voyage were placed in Mr. Busk's hands for examination and description. His report on the new species thus obtained is published in the narrative of the voyage, and forms an important addition to our knowledge of these animals.

Among the facts of anatomical interest which have been successfully worked out by Busk in the organisation of the Polyzoa, his demonstration of the structure of the *avicularia* and *vibracula* deserves special mention. He has given by far the best account which had been hitherto published of the structure and functions of these remarkable and enigmatical bodies, while he insists on their value in affording characters for classification. His very instructive and expressive figures form part of the illustrations of Polyzoal morphology contained in the morphological atlas of Victor Carus.

It was about this time that Busk undertook, for the Palæontographical Society, a monograph of the fossil Polyzoa of the Crag,—a task for which his knowledge of the recent species had eminently fitted him. But his geological work was by no means confined to researches among these lower forms of life. In 1864 he made a journey to Gibraltar along with Dr. Falconer, for the purpose of investigating the ancient fauna which had been preserved in the caves of that region. The results of the joint labours of the two explorers were embodied in a report read at the Norwich Meeting of the British Association in 1868, and more fully in a complete monograph on the subject subsequently published. Among other palæontological contributions may be mentioned his observations on certain points in the dentition of fossil bears, as affording good diagnostic characters, and on the relations of *Ursus priscus* to *Ursus ferox;* also his descriptions of three extinct species of elephant, the remains of which were collected by Capt. Sprat in the ossiferous caverns of Zebbung in the Island of Malta; his report on the animal remains in the Brixham Cave; and a report on the animal remains found by Col. Lane-Fox in the High and Low Terrace-gravels at Acton and Turnham Green. All these communications bear evidence of his skill in recognising palæontological characters and in detecting their relations with those of living forms, while his study of fossil mammals, and his comparison of these with existing species, suggested to him an ingenious method of graphically representing the dimensions and proportions of mammalian teeth.

It was somewhat later than this that his attention was largely given to ethnology, and the Anthropological Society not only owes to his pen many valuable memoirs, but bears evidence of judicious management and administrative capacity in his labours as its President and as a member of its Council. Along with Dr. Carpenter and Dr. Falconer he formed one of a Commission which visited France in order to take part in the Conference which was held there for the purpose of inquiring into the circumstances attending the asserted discovery of a human jaw in the Gravel at Moulin Quignon, near Abbeville. Among his other anthropological work will be found many interesting comparisons of crania belonging to various nations. These investigations were carried on chiefly by means of a systematic method of measurement, which he advocated as affording a uniform basis of comparison, by which anthropological studies might be facilitated and the data of comparison rendered more definite and precise.

At a time when the German language was much less understood in this country than it is at present, Busk performed an important service by giving to the English student an excellent translation from the German of Steenstrup's famous treatise on the alternation of generations, and, in collaboration with Huxley, a translation of Kolliker's valuable manual of human histology.

The last piece of work which devolved on him was the preparation of a Report on the Polyzoa collected during the voyage of the *Challenger*. The first part of this important work was completed in 1884, and has been already reviewed in NATURE. It forms an admirable exposition of the additions made to our knowledge of these animals by the great exploratory voyage; and amply realises all that had been expected from one who had made the Polyzoa the subject of so much careful and philosophic study.

The second and concluding part of the Report he left behind him in a condition nearly ready for the press, and under the judicious supervision of the proofs by his eldest daughter—through whose loving care during his last months of suffering he was enabled to carry on his work to completion—is now quite ready for publication.

The many-sidedness of Mr. Busk's mind was one of the most striking features of his clear and comprehensive intellect, and naturally obtained for him distinctions and honours in many and various departments of science. He was early elected a Fellow of the Royal Society, of which he was afterwards nominated one of the Vice-Presidents, and on the Council of which he served on several occasions. He was more than once President of the Microscopical and Anthropological Societies, was Zoological Secretary of the Linnean Society, and would have been made its President were it not that, notwithstanding the warmly expressed solicitations of the Council of that body, he felt that the labour of the Presidential chair was greater than he believed himself justified in undertaking.

In recognition of the eminence he had attained as a surgeon during the professional period of his life, and of the interest he had always continued to take in the welfare of his profession, he was elected in 1871 to the Presidency of the Royal College of Surgeons. He was one of the Trustees of the Hunterian Museum of the College, and continued for three years to hold in connection with that Museum the Hunterian Professorship of Comparative Anatomy. He was a Member of the Senate of the University of London, for many years Treasurer of the Royal Institution of Great Britain, and had more recently been nominated one of the Governors of Charterhouse School.

For his researches in zoology, physiology, and comparative anatomy the Royal Society in 1871 awarded to him the Royal Medal, while for his palæontological researches he afterwards received from the Geological Society the Lyell and Wollaston Medals.

On the passing of the Cruelty to Animals Act, intended to regulate the performance of experiments on living animals, he was appointed by Government inspector of the various medical schools and physiological laboratories registered under that Act in England and Scotland; and the judgment and skill with which he performed the difficult duties of the office bear ample testimony to the wisdom of his appointment. Abhorring the infliction of unnecessary pain, he saw that for the advancement of knowledge which might tend to the alleviation of human suffering such experiments were not only permissible but called for, while at the same time he set himself strenuously against the infliction of pain which might be avoided, and against the institution of experiments which did not hold out obvious promise of the results which alone would justify them.

He was a genuine lover of Nature, deriving unalloyed pleasure from all that was beautiful in the external world; and the writer of this notice can well remember the enthusiasm with which he would recall the vegetation of the lower reaches of the Thames—amid which his early work on board the *Dreadnought* lay—with its rich growth of Sagittaria, and Butomus, and Sedges, and picturesque water-weeds, long since swept away before the spread of manufactures and the encroachments of civilisation.

Generous and liberal to his fellow-workers, with his rich store of material always at their disposition, his loss will be long and deeply felt by the many who profited by his friendship. Free from all selfish and personal ambition, and pursuing his investigations for the sake alone of the truths which might result from them, he cared little about asserting his claims to discovery, and would rest satisfied with the belief that, whoever may be the discoverer, human knowledge would be the gainer.

And yet, though he had no ambitious longing for reputation, Busk was no cynic. He could appreciate the esteem of those whose esteem was worth having, and few men had a larger number of genuine admirers, or gathered around them a wider circle of sincere and attached friends. And not alone to the fields in which he himself worked did he extend his interest and sympathies. Amid the labourers in very different departments of thought he found some of his most cherished friends—frequent and always welcome guests at his hospitable home. For these, and for all who had enjoyed the privilege of his friendship, the sorrow at his loss will be softened by the ennobling memory of his life.

GEO. J. ALLMAN

BRITISH ASSOCIATION, SECTION B: DISCUSSION ON THE NATURE OF SOLUTION

IT may perhaps be convenient to those chemists who have announced their intention of joining in the proposed debate in Section B, at the approaching meeting of the British Association, that, having accepted the invitation of the President to open the discussion, I should indicate briefly the general nature of the subjects upon which I shall offer some remarks, and the order in which I shall probably take them.

After an historical sketch of the theories which have been framed with the object of explaining the constitution of saline and other solutions, the phenomena of solution will be dealt with somewhat as follows:—

Thermal and volume changes occurring in the act of solution and their mutual relations. How far and under what circumstances are thermal and volume changes to be considered as indicating chemical change?

The molecular volumes of salts in solution. The specific heat and vapour pressures of salt solutions. The relation of solubility to molecular volume, to fusibility, and to the composition of the liquid.

Action of solids and especially of porous bodies on solutions. Phenomena of supersaturation.

What is chemical combination, and is there any criterion by which it may be distinguished from adhesion or mechanical combination?

In consequence of the very wide-reaching character of the subject, it will not be possible to take up the question of solution except as relating chiefly to solids, and especially salts, in water. For the same reason I cannot fully discuss the phenomena of absorption-spectra nor generally the action of solutions upon light, but I hope some of those chemists who have worked on this part of the subject will be present, and will give us the benefit of their experience.

There will of course be a great number of questions incidentally touched upon in my opening, which may well form the basis of remarks from other speakers, such as—

How is saturation to be explained, *i.e.* why is there generally a limit to solubility?

Is there any general connection between solubility and atomic weight in a series of compounds in which only one constituent varies?

What becomes of water of crystallisation when a salt containing water is dissolved in water?

WILLIAM A. TILDEN

The Mason College, Birmingham

THE RECENT VOLCANIC ERUPTIONS IN NEW ZEALAND

WE have been favoured by Dr. Hector, F.R.S., Director of the Geological Survey of New Zealand, with a copy of a Preliminary Report drawn up by him for the New Zealand Government regarding the volcanic eruptions of last June in the North Island. It is gratifying to find that the hope expressed in NATURE (p. 322) has been so promptly fulfilled, and that the investigation of the remarkable phenomena has been undertaken by so competent an observer as Dr. Hector. The following is his Report, but it is merely a preliminary outline, and will no doubt be followed by much ampler details.

"*Colonial Museum of New Zealand, Wellington, June* 23, 1886

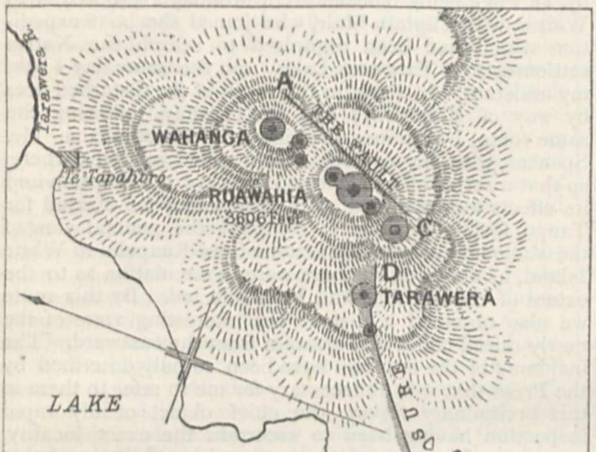
"According to instructions from Government, I proceeded to Tauranga on the evening of Thursday, the 10th instant, in the colonial gunboat *Hinemoa*, and arrived there on Saturday afternoon. At Tauranga I engaged the services of Mr. Spencer, a skilful landscape photographer, and on Sunday our party, seven in number, drove to Rotorua by the Oripi Road, the ordinary route by Te Puke being blocked On Monday I proceeded to Wairoa with Captain Mair, who joined the boat expedition which had been organised to search the Native settlements on Tarawera Lake. On the same day I sent my assistant, Mr. Park, to the south of the disturbed area by way of Kaiteriria; and on Tuesday, following the same route, I examined the vicinity of Rotomahana. Mr. Spencer, with his camera, accompanied me everywhere, so that a series of well-selected views of the eruption and its effects was obtained. On Wednesday we started for Taupo, feeling anxious to complete the general view of the whole line of volcanic activity from Ruapehu to White Island, as alarming rumours were in circulation as to the extent of country that had been affected. By this route we also obtained a distant but interesting view of the newly-raised cones of Tarawera from the eastward. The incidents of the eruption have been so fully described by the Press that it is unnecessary for me to refer to them in this preliminary report, the chief object of my rapid inspection having been to ascertain the exact locality, nature, and extent of the outbreak, and its probable consequences to the district. A complete geological examination of the district has therefore been deferred until a more favourable season for field-work, and until the volcanic activity has sufficiently subsided to admit of accurate observation.

"The focus of the disturbance was ascertained to be in a line extending from seven to ten miles in a north-east to south-west direction from the north end of the Tarawera Range to Okaro Lake (see plan.) The northern part of this line is occupied by the Tarawera Range. This range has three summits, the northernmost being Wahanga; the central, Ruawahia, 3606 feet alt.; and the southernmost, Tarawera Mountain proper. The southern part of the line previous to the outburst was a depression occupied by Rotomahana Lake, surrounded by low undulating country composed of pumice-sands and overspreading deposits of siliceous sinter, most of which were connected with active geysers, amongst which the most famous were those at the Pink and White Terraces.

"From the most reliable evidence it appears that the outbreak commenced at ten minutes past two on the morning of the 10th, by an eruption from the top of Wahanga, attended by a loud roaring noise, and slight earth-shocks. In a few minutes this was followed by a similar but more violent outburst from the top of Ruawahia—the middle peak of the range, and after a short interval this phase of the eruption culminated in a terrific explosion from the south end of Tarawera Range, north-east of Lake Rotomahana. For nearly two hours this was the only phase of the eruption, and was accompanied by the ejection of vast quantities of steam, pumice-dust, and hot stones, forming huge towering clouds, illuminated by lightning flashes.

"It was at this time also that a great crack or fissure (A C on plan) was formed along the east face of the Tarawera Range. I only had a distant view of this fissure from the eastward, but Mr. Percy Smith, the Assistant Surveyor-General, who had a near view from the sides, reports that the whole east end of the mountain has been blown away, and that the *débris* covers the country to a distance of many miles. The white terrace of pumice-sand that I saw was singularly flat-topped, and seemed to slope abruptly from the mountain like a huge embankment 500 feet high. Besides these heavy sands that lodged close to the fissure in the mountain side, the lighter dust was spread out in the form of stratified clouds, which were distinctly seen, at this period of the eruption, from Rotorua, Tauranga, and Taupo.

"The cloud thus formed discharged its contents for the greater part in a direction to the eastward of the mountain, reaching as far as Te Teko and Fort Galatea, and to the westward as far as Wairoa. The earth-shocks, however,



Stanford's Geog^l Estab^t

during this period of the eruption do not appear to have been of extreme violence, or to have created much alarm beyond that part of the district lying in the immediate vicinity of the volcanic eruption; but shortly before four a.m. a violent outburst of a totally different nature was experienced, accompanied with loud reports that reverberated through the atmosphere to enormous distances. The first notice of this outbreak was an earth-shock that appears to have been much more widely felt than those previous, and chiefly in areas where hot springs occur. This development was attendant on the outburst of an immense volume of steam—carrying pumice-dust and fragments of rocks to an enormous altitude—which proceeded from the site of Rotomahana Lake, causing the formation of a dense cloud in the higher atmosphere, that spread in definite directions, its advancing edge being marked by electrical discharges of the most awe-striking character. At first the wind was from the south-east, and the inhabitants of Rotorua appear to have been terrified by the approach of this hideous cloud, when suddenly the wind sprang up from the south-west and arrested its progress in that direction, turning it off towards the north-east, at the same time condensing the vapour of the cloud to such an extent that the suspended solid matter dropped on the surface of the earth in the form of mud, smothering the country, and leading to the disastrous results experienced at Wairoa. By six a m. the period of active eruption appears to have closed, and since then the display of energy in a modified form has also rapidly declined.

"The following are the chief points which require notice in this report:—

"I. *Focus.*—Tarawera Range, about 3600 feet above sea-level, is an isolated and very conspicuous object in the scenery of the Lake District. It slopes from the east side of Tarawera Lake—the level of which is about 1000 feet above the sea—and previous to the eruption rose very abruptly, with mural precipices and columnar rocks, especially on its western and southern escarpments. It was no doubt judging from this feature that Dr. Von Hochstetter was led to class Tarawera Mountain with the Horohoro Range, as being part of his older or sub-marine-formed volcanic series, and a remnant of the great plateau (Von Hochstetter, "Reise der Novara," i. 106), the surface of which denotes the original level of the country prior to the production of its present broken surface by the excavation of valleys, by the up-bursting of volcanic mountains, and the consequent subsidence or breaking-in of large cavities that are now occupied by lakes. He nevertheless maps Mount Tarawera as belonging to his recent volcanic group, and also alludes to it in other parts of his work as being largly composed of obsidian. I have never ascended the Tarawera Range, but have examined its slopes and found them to be composed of lavas of a high acidic or rhyolite type, in the form of flows intersected by dykes, and containing, amongst other rocks, large quantities of compact and vesicular obsidian. From this I conclude that the mountain really is one of recent volcanic origin, belonging to Von Hochstetter's new volcanic series, and that its abrupt outlines have resulted from fractures and subsidences of its flanks. According to this view it is natural to assume that the still-imperfectly-cooled mass of lava in the heart of this volcanic mountain has given rise to the long-continued (historically speaking) solfatara action at high temperatures that created the attractive wonders of the Rotomahana. It has been stated that no Native tradition exists of Tarawera having been the site of previous activity, but the range culminates in three distinct peaks, the meaning of the Maori names of which —according to Mr. Locke, M.H.R., and other authorities —clearly contradicts this assumption. This consideration has interest, as a sudden development of volcanic activity in a new locality, or in an ancient and greatly-denuded formation like the trachyte breccia that forms the Horohoro, would have been more serious and significant than the mere temporary revival of the expiring energies of a recent focus of volcanic force.

"II. *The Vents.*—As viewed across Rotorua Lake, on the 13th, from the point where the Tauranga Road emerges from the bush, Tarawera Range appeared to have quite lost its former characteristic outline. The deep gap dividing Wahanga, the northern peak, from Ruawahia, the central one, was almost obliterated, and the abrupt, precipitous sides of the mountain were everywhere softened by great slope deposits of material ejected from the volcanic vents, consisting of stones and dust of a grey colour. Along the edge of the range seven distinct points were seen to give off steam from flattened conical heaps of dark-coloured *débris*, and at intervals these vents threw off large volumes of steam and vapour, darkened to a reddish hue by solid matters, which were discharged to a height estimated at from 200 feet to 500 feet. Four days later, when viewed from the eastward, the same range showed a similar appearance, allowing for the change in direction; but the cone on the summit of Ruawahia had evidently accumulated with greater rapidity than the others, and had acquired lateral cones, giving its outline a similar appearance to that of Rangitoto, near Auckland.

"During two clear nights I watched the eruption from these vents, and could distinguish them against the sky with a powerful binocular telescope; but I never observed any illumination of the ascending steam clouds, as if from the surface of an incandescent mass within the vent, nor was there any sign of any outpouring of lava, either from these vents or from cracks or fissures in the sides of the mountain, during the time of my visit. In addition to the above-mentioned conical vents on the summit of the range, along its eastern side the line of fissure already alluded to was distinctly visible, emitting wreaths of steam. This line of fissure lay in an oblique direction, so that it appeared to gain in elevation along the sides of the mountain from north towards south, but not sufficiently so as to indicate for it a direction that would make it continuous with the great fissure south of Tarawera, but rather in the direction of line A C on plan. It is below this fissure-line on the eastern flank of the range that bulky terrace-like accumulations of pumice-sand have been formed, and if this eruption should ever reach the stage of producing lava, which from other circumstances I think hardly likely, it is from this fissure that I should expect the lava to exude.

"III. *The Great Fissure.*—This is the most remarkable and characteristic feature of the late eruption, and the chief origin of the disastrous results which attended it (B D on plan). A good view, but much obscured by steam, was obtained from the hill called Te Hape-o-Toroa —alt. 2300 feet—by Mr. Park on the 14th, and by myself on the following day. This fissure seems to commence as a narrow rift at the northern end from the great rent which has been formed in the south end of Tarawera Mountain. This rent is a most wonderful feature. It is not a slip from the mountain side, but appears as if a portion of the mountain measuring 2000 feet by 500 feet, and 300 feet deep, had been blown out, leaving a ragged, rocky chasm, from which steam was being discharged in rapidly-succeeding puffs. The eastern side of this chasm was brightly tinted, as if by the efflorescent deposit of a mineral substance, probably ferrochlorides. Sulphur has been mentioned as a deposit from this recent outburst by some who have witnessed it; but this is hardly a possible result of such rapid volcanic developments.

"The view I obtained of the extent of this chasm south was much obscured by numerous volumes of steam blowing off from the newly-formed fumaroles that occupied the site of Rotomahana. From the eastern slope of Te Hape-o-Toroa we looked right into the fissure, and, as far as I could see, it appeared to have a nearly straight boundary of undisturbed ground on its eastern side, extending from the Tarawera chasm to within a few chains of Lake Okaro, thus intersecting the Rotomakariri or the cold lake, the Rotomahana Lake, and the valley extending from thence southward. The west side of the fissure, on the other hand, is very irregular in outline, and is continually being altered by the falling-in of its precipitous walls, as the hills are undermined by the action of powerful geysers, seven in number, which at irregular intervals throw up great volumes of boiling water, with stones and mud, to a height of 600 feet to 800 feet from the bottom.

"It is only by occasional glimpses during the breaks of the steam that any idea can be formed of the nature of the bottom of this huge fissure; but it seemed as if it was entirely occupied by large circular areas of mud, seething and boiling in such a fashion as to convey the impression of its being in a very liquid state. These mud-pools are separated from one another by comparatively solid ground, and in some cases, especially towards the eastern side of the fissure, what appear to be small pools of water with sedgy margins could even be distinguished; but the difficulty of estimating distances and depths through the steam-clouds rendered the observations made very uncertain.

"The largest of these mud geysers appeared to be that rising from the position formerly occupied by the Pink Terrace, but the most interesting is one a mile further south, which, unlike the others, does not spring from the bottom, but from the comparatively high ground on the west side of the fissure, and, owing to the obliquity with which the fragments are thrown out, is gradually building up a conical mound, which already has attained an altitude of several hundred feet (Mount Haszard, on plan). At the southern extremity the fissure is bounded by a bold semicircular extremity, from the base of which powerful steam jets are escaping; but there was no evidence that it was prolonged by a crack or fissure, or fault, or other displacement of ground, nor was there any evidence that the fissure had been produced by any inequality of the movement of the ground bounding it, but rather that it was caused simply by the removal of material which formerly occupied its space. Its direction, as far as could be ascertained, is N. 50° E., which is the general line of direction that would connect all the more active geysers between Tongariro and White Island.

"IV. *Matter ejected during the Eruption.*—The quantity of matter which was ejected during the different phases of the eruption was very large. In the first place, stone fragments were scattered from the earlier eruptions of Tarawera over an area of country extending to the eastward as far as Te Teko, and even, some say, to Fort Galatea; while in the opposite direction they are not reported to have fallen at any place farther west than Wairoa, a distance of six miles. None of the fragments which I collected are other than portions of rocks of the district, nor do they present in the slightest degree the character of volcanic bombs or lapilli formed from lava or rock material in a state of fusion. Yet there can be no doubt, if we can accept the evidence of the eye-witnesses, that these rock-fragments must have, in some cases, reached the ground in a partially incandescent state. Next followed the great ejection of pumice-sand, which forms enormous deposits in two localities: the one is on the eastern slope of Tarawera Mountain, already described, the nature and origin of which I had no opportunity of ascertaining; the other deposit of this nature is chiefly on the western side of Rotomahana fissure, and was no doubt ejected at the commencement of the second phase of the eruption. Over a district of twenty-four square miles south of Tarawera Lake, and on an almost equal area to the north and east of the lake, the whole surface of the country has been covered with this pumice-stone so thickly as to obliterate in a great measure the natural features, partly filling the gullies and enveloping all the hills as if with a deep mantle of snow, so that not a trace of vegetation can be seen, from the highest peaks, such as Te Hape-o-Toroa, which is 2300 feet above the sea, down to the level of the lake. The thickness of this deposit could not be ascertained at the time of my visit, as no slips had occurred in it and no sections were to be seen. It consisted of fine-grained and gritty pumice-sand, slightly crusted on the surface by the action of the rain, which also caused it to assume a slightly greyish tinge; but underneath it was a pure white, and at a depth of 12 inches to 18 inches from the surface had still a high temperature on the sixth day after the eruption.

"Lying on the surface of this deposit, especially on the slopes directed towards the fissure, fragments of considerable size of various kinds of rocks were scattered about, and among these were masses evidently derived from the sinter of the terraces, and, from the manner in which these fragments appeared to occur in quantities where the finer dust had been blown from the surface, it is probable that the lower layer of the deposit will prove to be composed of coarser material than the upper. The boundary-line of this dazzling white deposit is very distinctly marked. It can be well seen where it passes over Kakaramea Mountain, dividing it, as it were, into two portions, one white and the other green. While traversing it we experienced a great downpour of rain, which formed the powdery material of the surface into little pellets; but it did not appear to be very absorbent, or to show any tendency to work up into an adhesive material. This is very different from what may be termed "the grey deposit" which is next to be mentioned, and which covers the country, from about two miles south of Wairoa, in a northerly direction towards the Bay of Plenty, as far as the Te Puke Settlement. This is the mud-forming deposit, and wherever it appears to have descended in a thoroughly pasty condition it coated the vegetation so heavily as to break limbs off lofty trees and to crush the smaller scrub flat simply by its weight. The sand, as already stated, appears to have fallen hot, so hot, indeed, as to set fire to the trees, the stumps of which were seen burning in many places; but there is nothing to lead us to suppose that this grey mud when it fell was even warm.

"It has been suggested by some that this moist deposit was mud thrown out from the bottom of Rotomahana Lake; but it is difficult to conceive how, in that case, it should have overleapt a strip of country four or five miles wide, where there is nothing but dry sand, before it reached Wairoa; and I think that a more likely source for its origin is to be found in the sudden condensation of the front edge of the great vapour-and-dust cloud when it suddenly met the violent cold south-west gale which averted it from Rotorua and directed it towards the sea-coast, where it spread over the sky and caused the darkness that was experienced at Tauranga and all over the country to the eastward. The great volume of this dust-cloud was directed towards the East Cape, dropping over the country in that direction a comparatively heavy deposit of brownish-black dust, so coarse as almost to be sand; while on its northern edge, as far east as Tauranga, the dust is of a light grey colour, and excessively fine in grain. A collection of all these different deposits has been obtained, and will be reported on as soon as the chemical analysis is complete. The impact of the moist deposit when it fell must have been very great, from the effects which it produced at Wairoa, where it appears to have attained its maximum thickness of about 12 inches in open level places free from any influence that would cause it to drift; on the flat spur above the bridge at the outlet of Rotokakahi its depth was found to be 9 inches, and in the Tikitapu Bush 4 inches; and from that point it gradually decreased towards the north. The action of rain upon this mud rapidly converts it into a semi-fluid condition, in which state it slides off the hill-slopes and fills the low grounds and watercourses; and where it has been thickly deposited it will thus be a constant source of danger for some time to come, but where only an inch or so in thickness it will, I believe, rapidly disappear, and, excepting that it may for a time deteriorate the pasture and destroy the existing vegetation, it will in the long run be an advantageous addition to the light pumice soils upon which it has been deposited, owing to its slightly absorbent properties. As for the light deposit of dust, which fell in a dry state, there is very little doubt that it will be all washed off into the soil with the first heavy rains that come. The distance to which this fine dust was carried was very great, exceeding at least 120 miles from the focus, in a direction between north and east; and the time it remained suspended in the atmosphere was at least eighty-four hours, as we passed through it in the *Hinemoa* when crossing the Bay of Plenty on the Saturday afternoon, as a peculiar yellowish fog, charged with pungent acid vapour and dust; and on the following afternoon we recognised the same fog-cloud still suspended in the atmosphere towards the north-east.

"V. *The Evolution of Steam.*—The enormous volume of steam rising from the site of Rotomahana Lake gives rise to a pillar of cloud that is visible in all directions over the country, having a diameter of about an eighth of a mile, and rising to a height of not less than 12,000 feet. Its effect is most impressive, especially in the morning and evening, when it is lighted up with gorgeous tints by the slanting rays of the sun when it is below the horizon, and all the surrounding landscape is in twilight. Although this steam-cloud receives rapid additions in its lower part from successive explosions, these do not generate any rapid movement through the mass of the cloud, so that, if viewed from a distance, it appears to be almost solid and immovable, except the changes that are gradually effected upon its lower portion by the movements of the atmosphere.

"VI. *The Propagation of the Earthquake Tremors.*—Earthquakes are the usual results of the violent concussions attendant upon violent outburst, and they afford the only clue which we can possibly have as to the depth below the surface of the earth at which the volcanic energy has been exerted. Thus, if the earthquakes are felt with only slightly-decreased violence to great distances from the focus of disturbance, it would indicate that the disturbance is a deep-seated one. On the other hand, if the earthquakes, although extremely violent close to the focus, are only felt at a moderate distance, the conclusion to be drawn is that the forces at work are only superficial. All reports agree that at the Wairoa, about four miles distant, which is the nearest point to the eruption from which any persons have survived, the shocks of earthquake during the first phase were violent and continuous; whereas at Rotorua, twelve miles distant, they were comparatively slight. The great earthquake at the commencement of the second phase appears to have been felt with considerable violence at Rotorua, and distinctly arrested attention for a distance of at least from sixty to seventy miles, but does not appear to have done any damage.

"During our visit the earthquake shocks in the vicinity of Rotomahana were still frequent and violent, but at Rotorua they were only experienced as gentle undulations; and I ascertained that they proceeded from the effects of the explosion from the Rotomahana fissure, and that the eruptions from the summit of Tarawera, which were clearly visible from Rotorua, did not produce the slightest apparent tremor at that distance. A few insignificant earthquake-rents were seen crossing the flats south of Kaitiriria, but only where there was a drop or unsupported bank.

"VII. *The Sounds.*—The sounds produced during the eruption must have been, from all accounts, appalling to those within a moderate distance. The crackling thunder produced by the electrical discharges, the terrific roaring of the high-pressure steam escaping through the volcanic vents, were combined with terrifying effects. Much has been said about noises heard at Auckland, Wanganui, and other places. From the times mentioned, these appear to have been due to the reverberating reports accompanying the Tarawera outbreaks. Some of these noises may have been propagated through the atmosphere, and reflected to the earth from the under surface of the stratiform cloud-sheets that were widely spread in various directions over the colony on that morning. Others, again, may have been propagated through the earth.

But I have been informed that at the whaling settlement of Tawaite, on the east entrance of Tory Channel, from six p.m. up to about eight p.m. on the evening of the 9th (the night preceding the eruption), loud booming reports were heard as through the earth. As these reports were previous to any symptom of the loud disturbances at Tarawera, this suggests that they may have resulted from a slight movement along the great fault-lines that traverse the North and South Islands in a north-easterly direction; and, in this case, the immediate cause of the Tarawera outburst may be found in a local fracture resulting from such movement.

"VIII. *Premonitory Symptoms.*—The only premonitory symptoms of the coming outburst which have been described were an oscillation in the level of Tarawera and Rotorua Lakes, and the occurrence of earthquakes for some months past in that district, where, as a rule, earthquakes are rarely felt. But neither of these are very characteristic incidents, nor would it be safe on future occasions to base any expectation of an eruption on such phenomena alone. The increased activity of the geysers and hot springs during the past season has also been advanced as having been a symptom of an approaching outbreak; but those who were most familiar with the district will agree that their variation was no greater than is usual under the influence of rapid changes of wind and atmospheric pressure. The reports of sympathetic outbreaks in other places along the line of volcanic energy from White Island to Ruapehu appear to be quite unfounded. The outburst has shown conclusively that the springs at Rotorua and Rotomahana are quite independent of each other, and of those at other places, thus confirming the observations made by Von Hochstetter long ago, that all the various points at which thermal springs occur are situated round the margins of lakes formed by subsidence of circular areas, and are not connected by an underground system of gravitational drainage.

"IX. *Conclusion.*—From the foregoing sketch of the character of the eruption I think there can be little question that it is a purely hydro-thermal phenomenon, but on a gigantic scale; that it is quite local and not of deep-seated origin, and that all danger is past for the present, so far as one can venture to form an opinion on such a subject. The extra activity of the *puias* which has been observed is no doubt owing to the heavy rains that, on the 9th, set in after the longest period of drought which has been experienced in that district for many years, and probably the frequent earthquakes which have of late agitated the ground have contributed to this activity by stirring up the sources of the water-supply, and facilitating the access of drainage-waters to the sources of the heat. But beyond what may be accounted for in this manner I believe there is no increased disturbance at Rotorua, Wairakei, Taupo, and other places. The quiescent condition of Tongariro and Ngaurahoe was plainly shown by the manner in which we observed it to be enveloped in snow. As a rule, on the scoria cone of Ngaurahoe, snow rarely lies, excepting in a few of the gullies, but melts almost as rapidly as it falls. On the morning of the 17th, however, the cone of Ngaurahoe was covered with a great mantle of snow; while the *puias* on Tongariro showed less than their usual amount of steam escaping. The only fresh activity which may be reasonably expected is that which I anticipate when sufficient rain has fallen to cause the overflow of Okaro Lake into the south end of the great fissure, as its former drainage outlet to the Rotomahana Lake appears to me to be completely filled up. If this should occur, and a fresh explosion takes place in consequence, it will be comparatively moderate in its effects, as, unlike Rotomahana, the soft, incoherent pumice deposits between the fissure and Okaro Lake are not sealed down by an enormous weight of siliceous sinter.

"For some time to come great variations must be expected in the activity of the newly-formed *puias* according to the manner in which changes occur in the atmospheric pressure; but, unless it can be shown that any local change in the barometer is experienced which is not shared by the surrounding district, the barometer affords no indication as to whether an eruption is or is not imminent. One of the most unfortunate results of the eruption, in addition to the disastrous loss of life and the destruction of the country, is the disturbance of the sense of security which has grown up amongst those residing at the Hot Springs; and I believe that many persons are so thoroughly shaken by the horrors experienced on the morning of the 10th that they will not recover their equanimity until they have been for some time resident away from the sounds, smells, and shocks that characterise the district. "JAMES HECTOR"

IN QUEST OF THE ORIGIN OF AN EPIDEMIC

IN our issue of the 8th ult. (vol. xxxiv. p. 213) we dwelt on certain general aspects of the reports lately laid before the President of the Local Government Board by the Medical Officer of the Department on milk-scarlatina, but these documents deserve more detailed consideration, for they show us our modern organisation for combating death and disease, by prevention, at its best. They show us, too, the men to whom the task of guarding public health is primarily committed at their best—patient, watchful, wary, tenacious of the thread of their investigation, eliminating this or that doubtful element, until finally they have tracked their quarry to its lair. In reading Mr. Power's report, we have been constantly reminded of that famous description of the contest between the man and the gun in Hugo's "Toilers of the Sea." Here the fight was man against disease, and the former has succeeded in his task. We shall endeavour in this article to show how Mr. Power, of the Local Government Board, succeeded in tracing, step by step, an epidemic of scarlatina to its source.

On December 18, 1885, Mr. Winter Blyth, the Medical Officer of Health of St. Marylebone, reported to the Board an extensive outbreak of scarlatina in his district. This he believed to be associated with the distribution of milk from a certain retailer in South Marylebone, who obtained his supplies from two farms, but the occurrence of the scarlatina appeared to be coincident with the milk-distribution from a certain farm at Hendon. Mr. Blyth had himself visited this farm, and, with the assistance of Dr. Cameron, the Hendon Medical Officer of Health, had carefully examined it, but was quite unable to discover in its sanitary circumstances or in the health of those employed about it any sort of clue to the cause of the infection of the milk. Accordingly he went with his story to the Local Government Board. It will be seen that Mr. Blyth had done his work exceedingly well: in one of the most crowded districts of London he had succeeded in tracing the scarlatina to a farm at Hendon; that is, he had made out a strong *primâ facie* reason for suspecting this farm; he had put a clue into Mr. Power's hands which he had not been able to follow any further himself. The first question for Mr. Power to answer was whether the Hendon farm was at fault or not. When this was answered it would be time enough to pursue the inquiry more minutely: it would be loss of time to try to dig out the fox unless it was first ascertained that he was in that particular earth. With this object, then, Mr. Power traced the milk from the Hendon farm to other milk-retailers in St. John's Wood, St. Pancras, Hampstead, and Hendon itself. From each of these, except St. John's Wood, the same story came. Until the end of November or beginning of December the district had for some months been exceptionally free from scarlatina, but about this date the disease had suddenly and notably increased, a large proportion of the recorded cases having occurred amongst the customers of milk-retailers dealing in the particular Hendon milk. These facts strengthened the case against the Hendon farm, but did not by any means establish it, inasmuch as the retailers in question obtained their supplies from other farms as well, and although in two cases these were situated in widely different counties, yet the case against Hendon was still in the condition of not proven, more especially as the St. John's Wood customers of that farm were certainly wholly free from scarlatina. Simultaneously with this investigation, another was being pursued at the incriminated dairy itself. But nothing was revealed here to show how the disease could be propagated from it as a centre. There was no scarlatina, nor any illness at all like scarlatina, amongst the persons employed about the farm, or their families and neighbours, at any such time or in any such way as to influence the farm or its produce. This, then, was the state of affairs on December 23, or less than a week after Mr. Blyth's report: there was a strong presumption against the Hendon farm, but outside human agencies had to be set aside as not having been operative. A thorough inspection of the farm itself was at once undertaken. Now it happened that the farmer in question, as well as one of the dealers who purchased from him, was particularly careful in all sanitary matters respecting his dairy. Every precaution had been taken by both to secure the farm and milk against any known sanitary fault or misadventure, and thus the inquiry advanced another stage. If the Hendon farm had caused the scarlatina, it did not do so in any commonly accepted way, such as through unwholesome conditions of water or drainage, or careless handling of milk or milk-utensils, by persons carrying scarlatina infection. This threw Mr. Power back on the theory of something in the cows themselves which caused the scarlatina to be distributed with their milk, and this formed his working hypothesis thenceforth. To discover this "something," and to understand its nature, it was necessary to ascertain in detail every parallel between the doings at the dairy farm and the observed scarlatina.

Here, then, we enter on the second and by far the most difficult stage of the investigation. The various districts supplied from Hendon were taken one by one; the quantities of milk obtained from Hendon by the dealers there, and by the same dealers from other sources, were ascertained; the dates of the notable incidence of the disease among the customers, and the degree of incidence at one period and another, were carefully observed, and compared, with the following results:—(1) The disease commenced at one and the same time in the four districts supplied from Hendon, viz. South Marylebone, Hampstead, St. Pancras, and Hendon. (2) In South Marylebone the disease increased day by day with increasing force up to the date of the inquiry. (3) In Hampstead and St. Pancras there was a cessation of ten days after the first attack, and then a larger number of persons were taken ill, the attacks continuing up to the date of the inquiry. (4) In St. John's Wood there was no scarlatina whatever down to the date of the inquiry, although the dealer there got five-sixths of his milk from Hendon. Were there any conditions in the farm operations parallel to these special phenomena? And first, was there any new condition pertaining to the cows coincident with the milk producing scarlatina at the end of November in four districts, continuously in South Marylebone, and after a break in the other three, while this condition was absent in the case of the cows supplying the St. John's Wood dealer? A tedious inquiry into such circumstances as the food, calving, health, arrival and departure of cows proved barren of result; nothing could be heard of for some time that was new or changed. But at last it appeared that on November 15 three newly-calved cows, purchased in Derbyshire, had come on the farm, and four from Oxfordshire on December 4. The practice of the farm was to isolate or quarantine new arrivals for examination for a week or ten days, and then to admit them into the stalls with the others. The cows on the farm at this period numbered 90 or 100, distributed in unequal numbers in three sheds, called the large, middle, and small sheds. The supply of the milk from the large shed went to South Marylebone only; that from the middle shed partly to South Marylebone, partly to Hampstead and St. Pancras; and that of the small shed to the two latter places and to St. John's Wood. So far we have this coincidence between the doings at the farm and the incidence of the disease—that the latter broke out after the time that the milk of the Derbyshire cows was added to the general stock, in three districts supplied from the farm; and that St. John's Wood, which did not receive any milk from the new arrivals, was free from scarlatina.

We have now reached what may be called the third stage of the case. In the first, what Mr. Power calls a "notable," and what lawyers perhaps would call a "violent," presumption had been made out against the Hendon dairy; in the second, a weaker presumption had been established against the Derbyshire cows which had been added on November 15, and whose milk began to be distributed to the three affected districts, and not to St. John's Wood, a few days later. But then, the facts of a continuous and increasing attack in South Marylebone, and the intermission of about ten days in St. Pancras and Hampstead, had to be accounted for, if the case was to be made out conclusively against the incriminated dairy. To deal with these, Mr. Power reversed the process hitherto pursued, which was that of pure induction from observed facts. He now employed the *a priori* process, and argued thus:—Taking the fact of uninterrupted progress of the disease in South Marylebone, and of the lull of ten days in the other two, if the dairy at Hendon be the cause of the outbreak, and if, as is most probable, the different results produced by the milk from the same cows was due to a difference in the relation of the cows themselves within the business of the farm, then we should find at the latter—(1) a change in the manner of distributing the milk of the Derbyshire cows, and this probably consisting in placing them, or one of them, in the "large shed," from which South Marylebone was supplied; (2) about the second week in December (the date of the recrudescence of the disease in St. Pancras and Hampstead), some of the Derbyshire or of the Oxfordshire cows, or some other cows which had been in close relation with them, were probably transferred to the "middle shed," from which these two districts were, it will be remembered, supplied; (3) as St. John's Wood, which was supplied from the "small shed," was free from scarlatina, it should be found that none of the new cows, or any other cow in close relation with them, had been placed there. Now, were any arrangements at the farm found corresponding with any or all of these *a priori* conclusions or probabilities? What was found on investigation was this: (1) The Derbyshire cows had been transferred towards the end of November into the "large shed" (the source of the South Marylebone supply), and remained here at the date of the inquiry; (2) the four Oxfordshire cows were transferred about December 11, two into the "large shed," and two into the "middle shed" (St. Pancras and Hampstead supply); (3) at no time had either the Derbyshire or Oxfordshire cows been transferred to the "small shed" (St. John's Wood). Here, then, both by positive and negative evidence, the presence of scarlatina in certain London districts was associated, first, with a particular dairy, and secondly, by a series of parallel events, with certain cows within that dairy. Mr. Power, having reached this point, felt justified in assuming, until anything to the contrary should appear, the presence of something in these cows competent to produce scarlatina in persons consuming their milk, and the inquiry was narrowed to determining what this was. All comparison with former experiences was for the present left out of consideration, the investigation proceeding strictly on the circumstantial evidence obtained and obtainable. A consideration of all that had gone before, and the absence of any alternative, led to the provisional adoption at this point of a theory of disease in the cows, and the probability was that this was an infectious disease, communicable from cow to cow, a disease, moreover, the existence of which was compatible with the animal affected feeding well, and milking abundantly.

The discovery of vesicles and ulcers on the teats and udders of cows in the large shed soon followed; the first to show the disease was one of the Derbyshire cows, the second one from Oxfordshire. After this the matter passed into Dr. Klein's hands; but with his report we have nothing to do here. A painful incident soon gave Mr. Power ample corroboration of the result which he had reached. The Marylebone dealer returned on the farmer's hands, on December 15, all his milk from the larger shed, and this was destroyed by pouring it into a pit dug on his land. The news of the destruction of milk spread among some of the poor people of Hendon, and some of them succeeded by the favour of friends amongst the cowmen in obtaining some of it on December 16. By the 20th scarlatina made its appearance amongst half-a-dozen of the families thus supplied. Conversely in South Marylebone about Christmas, when these Hendon families were falling ill, the disease ceased almost suddenly, and there were no fresh attacks, except such as were referable to infection from previous sufferers.

A thorough examination of all the cows showed that the disease had spread to every one of the three sheds, and the farmer was accordingly advised to seek out every cow then or afterwards affected with sore teats or udder, or any other ailment, to isolate her and keep all her milk out of the business, and prevent cowmen employed about the sound cows from attending the infected ones. These precautions were taken from January 1, and were barely in time to prevent an alarming increase of scarlatina in all the districts served from Hendon, including St. John's Wood, where the appearance of scarlatina corresponded to a nicety with the appearance of the cow-disease in the animals in the small shed. The milk from the Hendon farm was ultimately given up by all the dealers concerned, with the result that scarlatina has disappeared from amongst the customers of the dealers here referred to in Marylebone, St. Pancras, Hampstead, and St. John's Wood. The work of demonstrating the nature of the cow-disease, and its connection with human scarlatina was not Mr. Power's, and from him the matter passed on to Dr. Klein. The former had succeeded in gathering up and connecting the scattered links of a chain of presumptive evidence against certain cows so strong as to be unassailable; and he had done this by the exercise of patience, sagacity, and acuteness which would have done credit to a great criminal lawyer weaving the web of circumstantial evidence around an unusually cunning forger or murderer.

THE ORIGIN OF VARIETIES

THE publication in the three last numbers of NATURE, by Mr. Romanes, of very important papers,[1] induces me to send the following lines as a contribution to the discussion upon them that is sure to ensue. He ascribes the origin of varieties to peculiarities in the reproductive system of certain individuals, which render them more or less sterile to other members of the common stock, while they remain fertile among themselves.

[1] I write from abroad, and have not yet seen the original memoir published by the Linnean Society.

I also have a theory which, while it differs much from that of Mr. Romanes, runs on curiously parallel lines to it, and was prompted by the same keen sense of an inadequacy in the theory of Natural Selection to account for the origin of varieties. I should not have published my views until they had been far more matured than they are had not the present occasion arisen.

It has long seemed to me that the primary characteristic of a variety resides in the fact that the individuals who compose it do not, as a rule, *care to mate* with those who are outside their pale, but form through their own sexual inclinations a caste by themselves. Consequently that each incipient variety is probably rounded off from among the parent stock by means of *peculiarities of sexual instinct*, which prompt what anthropologists call endogamy (or marriage within the tribe or caste), and which check exogamy (or marriage outside of it). If a variety should arise in the way supposed by Mr. Romanes, merely because its members were more or less infertile with others sprung from the same stock, we should find numerous cases in which members of the variety consorted with outsiders. These unions might be sterile, but they would occur all the same, supposing of course the period of mating to have remained unchanged. Again, we should find many hybrids in the wild state, between varieties that were capable of producing them when mated artificially. But we hardly ever observe pairings between animals of different varieties when living at large in the same or contiguous districts, and we hardly ever meet with hybrids that testify to the existence of unobserved pairings. Therefore it seems to me that the hypothesis of Mr. Romanes would in these cases fail, while that which I have submitted would stand.

The same line of argument applies to plants, if we substitute the selective appetites of the insects which carry the pollen, for the selective sexual instincts of animals. Both of these, it will be remembered, are mainly associated with the senses of smell and sight. If insects visited promiscuously the flowers of a variety and those of the parent stock, then—supposing the organs of reproduction and the period of flowering to be alike in both, and that hybrids between them could be produced by artificial cross-fertilisation—we should expect to find hybrids in abundance whenever members of the variety and those of the original stock occupied the same or closely contiguous districts. It is hard to account for our not doing so, except on the supposition that insects feel a repugnance to visiting the plants interchangeably.

No theme is more trite than that of the sexual instinct. It forms the main topic of each of the many hundred (I believe about 800) novels annually published in England alone, and of most of the still more numerous poems, yet one of its main peculiarities has never, so far as I know, been clearly set forth. It is the relation that exists between different degrees of unlikeness and different degrees of sexual attractiveness. A male is little attracted by a female who closely resembles him. The attraction is rapidly increased as the difference in any given respect between the male and female increases, but only up to a certain point. When this is passed, the attraction again wanes, until the zero of indifference is reached. When the diversity is still greater, the attractiveness becomes negative and passes into repugnance, such as most fair-complexioned men appear to feel towards negresses, and *vice versâ*. I have endeavoured to measure the amount of difference that gives rise to the maximum of attractiveness between men and women, both as regards eye-colour and stature, chiefly using the data contained in my collection of "Family Records," and have succeeded in doing so roughly and provisionally. To determine it thoroughly, and to lay down a curve of attractiveness in which the abscissæ shall be proportional to the amounts of difference, and the ordinates to the strength of attraction, would require fresh and special data that have yet to be collected and discussed, and about which I will not now speak. Suffice it to say that such inquiries as I have made confirm, so far as they go, the reasonable expectation that some more or less regular curve will be found to exist in respect to any given quality or group of qualities. Each individual would possess his own characteristic curve, but the average of the tastes of many individuals would, as all statistical experience justifies us in believing, afford fairly constant data. These would enable us to argue out the hypothesis I have submitted, with mathematical precision; at all events, with much more closeness of reasoning than is now possible. But this much may even now be averred: (1) That the existence of a law of sexual selection such as I have described, is probable; (2) if it exists, it would have a powerful influence in rounding off any incipient variety that differed notably in any one particular or in any group of particulars from the parent stock; (3) it would be favourable to the vigour of the variety, after it was once fairly started, by checking too close interbreeding.

It must be borne in mind that differences overlooked by ourselves, who are singularly deficient in the sense of smell, and who are hardly able to distinguish without scrutiny even the sexes of some animals, may seem very considerable to the animals themselves. Also that the only differences that we are able to recognise between two varieties may connote a host of unseen differences, whose aggregate would amply suffice to erect a barrier of sexual indifference or even repugnance between their members.

FRANCIS GALTON

August 23

NOTES

THE Local Committee of the Birmingham meeting of the British Association has issued a descriptive programme of the excursions which have been arranged for Saturday, September 4, and Thursday, September 9. The programme covers 120 pages, and has been compiled by several specialists with the greatest care. There are twenty-seven excursions in all, besides a geological excursion to the Lower Palæozoic district of Shropshire. This excursion will last six days, from September 9 to September 15. Prof. Lapworth will take the leadership.

THE French Association for the Advancement of Science has concluded its annual meeting at Nancy, after having resolved that the 1888 session will be held in Oran, Algeria; Col. Laussedat has been elected President for that meeting. The 1887 session will be held in Toulouse, as decided at the last meeting.

AT the Buffalo meeting of the American Association it was proposed to devote especial attention to the study and discussion of the interesting phenomena of the Niagara Falls and the gorge below. On Friday, August 20, one or more preliminary papers of an expository and suggestive nature were to be given, intended to prepare the way for a short field-study of the Falls and the gorge, which occupied Saturday. Monday forenoon would be devoted to the discussion of the gorge and the problems to which it gives rise. A new survey of the Falls has been arranged for, so that a considerable addition to the data for the computation of the rate of recession will be at command, and it is expected that new observations in other important lines bearing upon the chronology of the gorge will be presented, and will throw fresh light upon the history of the formation and recession of the Falls, and upon the utility or untrustworthiness of the gorge as a geological measure of time.

WE learn that the Lick Trustees—after a most thorough discussion of the various plans and specifications submitted for the mounting of the 36-inch refractor of the Lick Observatory and for the steel dome to cover the same, and with a special consideration of the element of time, which circumstances now make one of vital interest to the work—have let the contract for the former to Warner and Swasey of Cleveland, Ohio, for 42,000 dols., and the contract for the latter to the Union Iron-Works of San Francisco for 56,850 dols. The Trustees acknowledge the very prompt and courteous manner in which Mr. Grubb has responded to their invitation, and the very great disadvantage to which he has been put by the remote situation of his works from California, &c. The President of the Trustees has stated that he believes that Mr. Grubb's idea of an elevating floor in principle offers the best solution yet submitted of the very difficult problem of a convenient chair for the observer with so large a telescope. The method of elevating the floor will have to be adapted to the peculiar circumstances of the site of the Lick Observatory, and the means to be commanded there with its very limited water-supply. This subject is now being carefully studied, and so far the only apparent obstacle to the adoption of Mr. Grubb's plan is the question of cost.

WE have to record the death, at Tomsk, of Alexander Krapotkin, on August 6, at the age of forty-five years. M. Krapotkin had done some good work for science in Russia. He had translated into Russian Mr. Herbert Spencer's "Principles of Biology," and Clerk-Maxwell's "Theory of Heat," and for several years contributed to Russian periodicals reviews of the progress of physical astronomy, much valued by Russian astronomers. In 1874 M. Krapotkin was exiled to Minusinsk in East Siberia, and there he helped Dr. Martianoff to organise a local museum; and for several years carried on meteorological observations, which were printed by the Kazan Society of Naturalists. His most important work, however, was a critical investigation of all our present knowledge of the stellar systems and constitution of stellar groups. Every known source in every European language was ransacked for data, though the difficulties he encountered in his peculiar position prevented him from bringing his work down to a later date than 1879. He hoped to complete the work, and publish it, after his expected liberation in September. His untimely death has put an end to this hope.

WE have received the third number of the *Journal* of a Society recently founded in Bombay, called the Natural History Society of Bombay, which, though it is young, appears to have abundant vitality. There are already several learned societies in India and Ceylon, all of which appear to be very successful; but the field is so vast and varied, and the number of men, servants of the Crown and others, capable of doing good work is so great, that it is impossible to have too many of these associations, and accordingly we welcome the new Society, and are glad to notice the energy it displays. In the number of the *Journal* before us, Capt. Becher describes the life (mainly the bird-life) of a Sind lake, Manchar, near the Indus; "A member of the Society" similarly compiles some notes on animal life in the rivers of British Deccan and Kandesh. Mr. Sterndale, one of the editors, has a paper, with illustrations, on abnormalities in the horns of ruminants, in which he expresses the opinion that there is neither persistence nor transmission in the abnormalities of antlered deer, but that they must be persistent in the case of hollow-horned ruminants, and that in the latter case the adage is true: "As the twig is bent, so is the tree inclined." Mr. Aitken, the second editor, publishes a list of the Bombay butterflies in the Society's collection, with notes. The collection appears to be far from complete in any direction. Dr. Kirtikar describes a new species of Alga (*Conferva thermalis Birdwoodii*), discovered among the hot-water Algæ in the hot springs of Vajrabai. There are, in conclusion, various zoological and botanical notes, and a list of presentations to the Society, which we notice in order to mention that they appear to be of great number and variety. One present is a collection of 105 birds. The new Society evidently has many friends and supporters.

AMONGST the great number of publications which are received from time to time from the Smithsonian Institution, two which have lately been issued help better perhaps than anything else to show the magnitude of the work of the Institution as a disseminator of scientific knowledge—a work, moreover, the sphere of which is limited only by the civilised world. The first of these is the list of institutions in the United States receiving the Smithsonian publications. The latter "are so distributed as to be accessible to the greatest number of readers," and the rules for distribution are accordingly of a very elastic kind, giving abundant discretion to the authorities. The publications are divided into three classes: (1) the reports; (2) the miscellaneous collections; (2) the contributions to knowledge. Of these, one, two, or all classes are distributed according to the demands of the neighbourhood to which they are sent, and all that is required in return is that they be "duly acknowledged, be carefully preserved, be accessible to any person who may wish to consult them, and be returned to the Smithsonian Institution in case the establishment at any time ceases to exist." The list of institutions in the United States receiving the publications under these conditions fills a pamphlet of about seventy pages, and numbers nearly 2000. They include various classes of schools and colleges, literary and scientific institutes, learned societies, public libraries, hospitals, &c., in wonderful variety. In looking through the list it is impossible not to recollect the trouble with which a few of our own public institutions succeeded last year in getting some of the Parliamentary papers published by the Government.

THE second publication to which we have alluded is the Smithsonian list of foreign correspondents, in other words, of institutions outside the United States to which the Institute's publications are sent. These reach the enormous number of 7969, every country on the globe with any pretence to civilisation being represented. It thus appears that an ordinary Smithsonian Report has a free circulation of about 10,000, and is spread all over the globe, from Pekin to Valparaiso, from Iceland to New Zealand. The exchange department of the Smithsonian is certainly not the least marvellous part of a marvellous institution.

ACCORDING to the latest consular report from Newchwang, in Manchuria, Seoul, the capital of Corea, is now in telegraphic communication with Pekin, and so with the outer world. The line runs through Moukden. Six years ago no European was allowed to visit Corea, and those who ventured to disregard Corean seclusion generally paid for their temerity with their lives: to-day a merchant in London might telegraph direct to the capital of the Hermit Kingdom.

A SHOCK of earthquake was experienced on Friday evening at Kilsyth, a mining town situated in Stirlingshire, about thirteen miles from Glasgow. About 9 o'clock a sharp rumbling noise of a few moments' duration was heard over the greater part of the town. Much vibration was noticed in many houses at the same time. People ran immediately into the streets, not knowing what had occurred, and many rushed off to the Craig Ends and Haugh pits, situated to the east and west of the town, thinking that one or the other must have been the scene of a great disaster. The shock was most distinctly felt in the north-east portion of the burgh. The weather at the time was close and dull.

ANOTHER slight shock of earthquake was felt at Malta at 8.30 a.m. on August 19. The captain of a steamer which arrived there on the 18th, officially reports that at about 9 o'clock on the evening of the 17th inst. he observed something like a blaze of fire coming out of the water. It was about 30 feet wide and rose to 100 feet above the water, and disappeared at once. The position of the steamer at the time was about 200 miles eastward of Malta. The blaze was observed at the head of the ship, and those on board were certain that it was not lightning.

A CURIOUS result of the volcanic eruption in New Zealand (according to the *Colonies and India*) is alleged to have been found in the sudden breaking up of the drought in Australia. It is said that the great Java earthquake of 1883 was the immediate forerunner of a long spell of dry weather in Queensland in that year, and that a welcome fall of rain in the same colony followed immediately upon the eruption of Mount Tarawera.

MR. F. W. PUTNAM'S last report of the explorations which he is conducting with Dr. Metz in Ohio for the Peabody Museum, deals with what is called the Marriott Mound, No. 1, forming part of the Turner group in the Little Miami Valley. The report describes with great minuteness the various objects found in this mound, of which numerous illustrations are given. The find was a rich one. The mound, though it had been ploughed over, was 2 feet high and 60 feet in diameter at the time of the examination. In the centre was found a mass of burnt clay in the shape of a basin, 2 feet in diameter, containing ashes, charcoal, burnt bones, pottery beads, and various shells used as ornaments. About 600 fragments of pottery, from 2000 to 3000 broken and split pieces of bones of animals (chiefly the deer and bear), shells of river clams, several objects in bone and stone, and some human remains, were amongst the objects found in the mound. Of the latter the principal were a perforated skull, various bones belonging to a different skeleton, a third skeleton, partly covered by a large hammered copper plate, and a fourth which was apparently that of a woman, with numerous personal ornaments near it. Mr. Putnam's report is confined to a bare description of all these and other objects found, and of their precise situations in the mound with regard to the basin in the centre and to each other.

AT the annual meeting of the Royal Society of Queensland, held at Brisbane on July 2, the President, Mr. L. A. Bernays, delivered an address in which he gave a brief *résumé* of the work of the Society during the past year, its meetings, and the publication of the papers read on these occasions, the endeavour to assist in the exploration of New Guinea by organising a fund for the benefit of the Forbes Expedition; the efforts to encourage special scientific pursuits amongst the members by the admission of Sections into its constitution. Finally, having dwelt on the importance of the conduct by the State of systematic instruction with the immediate object of fostering numerous industries which the marvellous range of soil and climate of the colony is capable of calling into existence, occasion was found to dwell on the value of technical and industrial botany, and the importance of its recognition in the plan and management of the colonial botanical gardens, and in the selection generally of objects publicly displayed for educational purposes. With regard to the Forbes Exploration Fund referred to by the President of the Queensland Royal Society, in December last Mr. H. Tryon suggested to the Council of the Society that such a fund should be opened in Queensland. This was done, and at the time it was closed 94*l*. was raised. Subsequently a further appeal was received on behalf of Mr. Forbes, whose operations had been suspended. This led to the fund being reopened, with the result of additional subscriptions being received, raising the total to 145*l*. 10*s*. For a Society which is quite young, and the total income of which is but little over 100*l*. per annum, this is a considerable donation to Mr. Forbes's work, even though Queensland has a special interest in New Guinea.

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Gazelle (*Gazella dorcas*) from Egypt, presented by Capt. Robbins; two Red-under-winged Doves (*Leptopila rufaxilla*) from Guiana, presented by Mr. S. Wells; a Barn Owl (*Strix flammea*), British, presented by Sir Henry Tyler; two Great Eagle Owls (*Bubo maximus*), bred in Shropshire, presented by Viscount Hill; three Yellow-headed Conures (*Conurus jendaya*) from South-East Brazil, presented by Mr. C. Rudge; a Raven (*Corvus corax*), British, presented by Mrs. Tatham; a Martinique Gallinule (*Porphyrio martinicus*) from South America, presented by Mr. J. M. Booker; two Common Boas (*Boa constrictor*) from South America, presented by Mr. T. H. Church; a Common Viper (*Vipera berus*), British, presented by Mr. R. B. Spalding; four Ruscon's Newts (*Molge rusconi*) from Sardinia, presented by Prof. H. H. Giglioli, C.M.Z.S.; two Black-eared Marmosets (*Hapale penicillata*), a Feline Dourocouli (*Nyctipithecus vociferans*), two Yarrell's Curassows (*Crax carunculata*), two Magpie Tanagers (*Cissopis leveriana*), two Ariel Toucans (*Ramphastos ariel*), two Laughing Gulls (*Larus atricilla*), a White-faced Tree-Duck (*Dendrocygna viduata*) from South-East Brazil, purchased; three Aldrovandis Skinks (*Plestiodon auratus*) from North-West Africa, two Common Slow-worms (*Anguis fragilis*), British, received in exchange; six Ribbon Snakes (*Tropidonotus saurita*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *AUGUST* 29—*SEPTEMBER* 4

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 29

Sun rises, 5h. 9m.; souths, 12h. 0m. 46·9s.; sets, 18h. 52m.; decl. on meridian, 9° 18′ N.: Sidereal Time at Sunset, 17h. 24m.

Moon (New) rises, 4h. 51m.; souths, 11h. 58m.; sets, 18h. 52m.; decl. on meridian, 9° 21′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 37 ...	10 54 ...	18 11 ...	14 4 N.
Venus	2 48 ...	10 27 ...	18 6 ...	17 51 N.
Mars	10 45 ...	15 38 ...	20 31 ...	13 40 S.
Jupiter... ...	8 5 ...	13 59 ...	19 53 ...	2 0 S.
Saturn... ...	0 46 ...	8 51 ...	16 57 ...	21 47 N.

Occultation of Star by the Moon (visible at Greenwich)

Sept.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
3 ...	γ Libræ	4½ ...	21 19 ...	22 13 ...	143 273

August 29.—Total eclipse of Sun: not visible in Europe· The central line crosses the West Indies, the Atlantic, and Southern Africa. The members of the British Expedition are prepared to observe the eclipse at Grenada, one of the Windward Isles, where the eclipse will occur soon after sunrise, having a duration of totality of about 4 minutes. In mid-Atlantic the duration will be 6 minutes. In Africa the eclipse occurs near to sunset, with a duration of totality of about 4 minutes.

Sept.	h.	
2 ...	11 ..	Mercury at greatest elongation from the Sun, 18° west.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Sept. 1,	20 27	*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 2,	1 22	*m*
				21 30	*m*
W Sagittarii ...	17 57·8 ...	29 35 S. ...	,, 2,	0 0	*m*
T Serpentis... ...	18 23·3 ...	6 13 N. ...	,, 4,		*M*
η Aquilæ	19 46·7 ...	0 43 N. ...	Aug. 29,	21 0	*M*
R Vulpeculæ ...	20 59·3 ...	23 22 N. ...	Sept. 3,		*m*

M signifies maximum; *m* minimum.

Meteor Showers

Amongst the radiants that have been observed at this season are the following:—Near γ Pegasi, R.A. 6°, Decl. 11° N.; near ψ Cygni, R.A. 306°, Decl. 54° N.; near λ Cygni, R.A. 311°, Decl. 35° N.; near ε Cephei, R.A. 335°, Decl. 52° N.; and near β Piscium, R.A. 345°, Decl. 0°. Fireballs are of frequent occurrence during this week.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
71 Pegasi	23 27 46 ...	21 52·3 N. ...	III.
19 Piscium	23 40 34 ...	2 51·3 N. ...	IV.
φ Pegasi	23 46 41 ...	18 29·2 N. ...	III.
D.M. − 0° 4585 ...	23 48 55 ...	0 31·6 S. ...	III.
30 Piscium	23 56 7 ...	6 38·9 S. ...	III.
47 Piscium	0 22 6 ...	17 15·6 N. ...	III.
57 Piscium	0 40 34 ...	14 51·2 N. ...	III.
7 Schjellerup	1 9 49 ...	25 9·9 N. ...	IV.
R Piscium	1 24 45 ...	2 17·6 N. ...	III.

GEOGRAPHICAL NOTES

IN a lecture delivered at Cooktown (published in the *Daily Observer* of Brisbane), Mr. H. O. Forbes described his work in New Guinea during the six months he remained there. He set up his winter camp at Sogere, three days' march from the coast, though only 25 miles in a straight line, on the slope of a steep mountain. His work here was varied and important. The meteorological station which was erected was placed under the charge of Mr. Hennessy, and the observations were continued down to the end of his stay. These consisted of records of the mercurial barometer, maximum and minimum, dry- and wet-bulb thermometers, and rainfall, and were recorded without interruption six times in every twenty-four hours. The mass of observations thus accumulated will take a considerable time to tabulate, especially those referring to the atmospheric humidity. Then there was the collecting of zoological and botanical specimens. A large portion of the herbarium consists of giant trees of the forest. It contains about one thousand specimens, one set having been sent to Baron von Müller to Melbourne. A great part of Mr. Forbes's own time was devoted to the survey and delineation of the geographical features of the country. He obtained angles from about fifty different stations and established a base of several miles in length, on which he had hoped to found the triangulation of the country between Sogere and Owen Stanley, and the north-east coast. He also paid a visit to the latter place, and there, as elsewhere, with a little management, found the natives extremely friendly and well-disposed. When Mr. Forbes found his funds failing, he determined, with Mr. Chalmers, on making a dash for Mount Owen Stanley, but the natives who were to have aided him fled in the night, apparently on account of the terrors inspired by the journey. He only got as far as Kaukari, a village two days' journey beyond Sogere. He says that no words can give a true idea of the break-neck, shattered, disrupted condition of the country between Sogere and the central ridges. Beyond the natural obstacles, however (and they appear to be very great), there appears no reason why British New Guinea should not be thoroughly explored, provided the natives are treated with conciliation and tact.

THE Hon. Duncan Gillies, Premier of Victoria, has received a deputation, consisting of members of various learned societies, who urged the expediency of Antarctic exploration. The deputation represented that whale-fishing would make the enterprise remunerative, but at the same time asked the Victorian Government to give encouragement to the project. The Premier, in reply, said that the Government would be willing to grant a subsidy to aid scientific discovery, and that he would ask the other colonies to do the same. In the meantime he would instruct the Agent-General in London to inquire whether steam-whalers would be disposed to embark in the enterprise, and what subsidy would be required.

THE annual meeting of the Association of Swiss Geographica Societies took place at Geneva, at the same time as that of the Society of Natural Sciences. Prof. Chaix was President. Geographical Societies exist now in Geneva, Berne, St. Gall, Aarau, and Neuchatel, and others are about to be established in Zurich, Basle, and Lausanne. Those in existence count altogether more than a thousand members. The paper which attracted most attention was one by Prof. Forel, on Lake Leman. He gave an historic sketch of the examination of the bed of the lake from Delabêche in 1819 down to the present day, from which it appeared that the knowledge of the central portion is very incomplete, while the rest of the lake is now well known. It is clear that there are two parts in the lake of wholly different character—one small and shallow, the other large, deep, and Alpine in its character. These two are separated by the Yvoise bank or bar, which is really a glacial moraine, as shown by the flints dredged up. These fragments of rock, found sometimes at a depth of 61 metres, are covered with moss of a beautiful green—a fact which appears to demand a reconsideration of the theory that light will not penetrate to more than 25 metres. A discovery in connection with the lake which M. Forel regards as a most interesting one in physical geography is that of a sub-lacustrine ravine through which the Rhone flows. Prof. Forel's long and laborious study of the lake entitled him, the President said, to the title "Prophet of Leman." Dr. Dufresne described the orohydrography of Brazil, and M. Brun recounted his adventures on the Gran Chaco. The Association discussed at some length various questions connected with the teaching of geography, especially the compilation by the allied societies of a manual of geography, and the establishment of geographical museums.

THE current number of the *Verhandlungen* of the Berlin Geographical Society (Bd. xiii. No. 6) contains two papers on the Congo region: one by Dr. Büttner on his journey from San Salvador to the Quango, and thence to Stanley Pool; the other by Lieut. Kund, who, with Lieut. Tappenbeck, was sent out by the German African Society in 1884. Their task was to explore the southern tributaries of the Congo, and to study their navigable qualities between Koango and Kassai. The length of the journey was, in all, 800 German miles, of which 340 was by water, and 460 by land. They succeeded in finding, between Koango and Kassai, three navigable rivers, the Wambu, Saie, and Kiulu; and they regard Lukenje, with its people, as practically a new discovery in the Congo basin. Dr. Joest writes on Minahassa, a peninsula in the north-east Celebes.

THE *Zeitschrift* (Bd. xxi. Heft 3) contains less matter of specially geographical interest than usual. A short paper, with an excellent map, discusses the improvements, which appear to have been great, made in recent years in roads and other means of communication in Asiatic Turkey. The greater part of the number is occupied with an exhaustive examination, by Herr Jung, of the census of India for 1881. The only real geographical paper is a summary of the report presented to the Brazilian Government on the surveys made for the purpose of the frontier between that empire and Venezuela.

THE last number of the *Izvestia* of the Russian Geographical Society (1886, ii.) is of great interest. It contains a beautiful map of the upper course of the Amu-daria, on the scale of 20 miles to an inch, including the space between the 36th and 41st degrees of latitude, and the 66th and 76th degrees of longitude. The whole of the Pamir appears on this map according to the recent surveys and barometric levellings of the Pamir Expedition, while a number of other surveys, including those of M. Kosyakoff (who accompanied Dr. Regel), the astronomical determinations of MM. Scharnhorst, Bansdorf, Schwartz, Skassi, Putyata, and Mr. Forsyth, as also the sketch map "of M. S. in and around Badakshan," have been taken into account. The same issue contains a very interesting paper by M. Grum-Grzymailo on the Pamir region; a paper, by M. Makaroff, on the double currents in straits, and especially in the Bosphorus (being a summing up of papers on this subject published in the *Memoirs* of the St. Petersburg Academy of Science); a most interesting account of the earthquakes at Tokmak in 1885; and, finally, the minutes of the proceedings of the Society brought up to a recent date, that is, embodying the sittings of the Society and its Sections as far as April last.

THE last issue (Nos. 5 and 6, 1885) of the *Journal* of the North China branch of the Royal Asiatic Society has a paper by Mr. Phillips on the seaports of India and Ceylon, described by Chinese voyagers of the fifteenth century, with an account of Chinese navigation. It is illustrated by a very curious old chart said to have been used by Chinese sailors who visited these distant places. In the present paper the route from Sumatra by the Nicobars to Ceylon is described; at a future time the writer will continue the maps to Arabia and Persia. The method of navigation by star charts, one of which is given, is very interesting. The whole paper shows that the Chinese visited these seas long before European navigators found their way there.

THE INSTITUTION OF MECHANICAL ENGINEEERS

THE summer meeting of this Institution for the reading and discussion of papers was held on the mornings of the 17th and 18th inst., at the Theatre of the Institution of Civil Engineers. On the afternoons of these days, and on the 19th and 20th, various works in and about London were visited. The Institution was entertained three years ago by the Belgian Engineers at Liége, and on this occasion Belgian Engineers have enjoyed the hospitality of the London members of the Institution.

The proceedings commenced with a few introductory remarks and a welcome by the President, Mr. Jeremiah Head, after which he read an address, taking as the text of his discourse the "Depression of Trade," to which Dr. Percy referred at the meeting of the Iron and Steel Institute in Glasgow last autumn, attributing it to over-production.

Mr. Head drew attention to the circumstance that mechanical engineers had done their utmost to make possible what had actually occurred, illustrating his remarks by recalling to the minds of the members some of their recent visits to works in various parts of England, where "the advantages of adhesion to a few types, and to but a few sizes of each type, of working to gauges throughout, of the piece-work system, of making for stock as regards all details, and taking from stock when erecting so as to avoid delays, impressed themselves strongly upon the members, who realised what rapid strides had been made in the direction of increased production at diminished cost." He instanced a steam-navvy, which was capable of doing the work of 80 to 120 human navvies, thus turning them into the ranks of the unemployed, and the flooding of our markets with American and Swiss watches, which, according to the evidence of a Liverpool watchmaker, was killing the British industry. The probable causes of these unfortunate circumstances were "diffusion instead of concentration, and adherence to old habits instead of quick appreciation of new and better ones."

Passing from the subject of the aid rendered by mechanical improvements towards over-production, the speaker referred to various commodities we send abroad as affecting our trade. "Some of these commodities may, in their production and sale, beneficially affect us now, and may also bring other benefits in the future; others may be profitable for the time being, but may tend to destroy future trade."

The address was listened to with interest and attention by the members, the meeting being one of the largest that has taken place in the metropolis for some time.

Two papers only were read on this occasion, the one by Mr. Borodin, of Kieff, and the other by Mr. Sandiford, of Lahore, both being on the working of compound locomotives, Mr. Borodin's paper also having reference to steam-jacketing. Mr. Borodin employed Mr. G. A. Hirn's system of investigation, with some modifications necessary to adapt it to locomotives working without condensation. Tests were first made in the locomotive testing-shop, where there was no dynamometer, and as only 90 per cent. could be utilised, high grades of expansion and comparatively low pressures had to be employed. The arrangements made were very complete; pressure-gauges and counters were observed, and indicator-diagrams taken at frequent intervals, the readings of which were tabulated. The results of each one and of all the tests, without exception, indicated a decreased consumption of moist steam when the jackets were working, the effect of the jackets including a decrease in the quantity of steam condensed during admission, a decrease in re-evaporation of water during expansion, and an increase of mean pressure in the cylinders. When variable rates of expansion were employed it was found that the consumption of steam per effective horse-power was larger at the higher rates of expansion, from which the conclusion may be drawn that when cylinders are too large they prevent economy in the consumption of steam.

The second set of trials was made with experimental trains, on ordinary and compound locomotives respectively, with jackets working and not working, but unfortunately as regards these experiments "the great want of success in the attempts to measure the quantity of water condensed in the jackets, as well as the impossibility of selecting a representative diagram of the mean work of the steam that should be sufficiently accurate for showing the mean power developed in the cylinders during the whole of the test, rendered it hopeless to estimate the effect which the jackets had upon the state of the steam in the cylinders." The comparisons were on this account only available with tests made when the jackets were not at work. The following were the final conclusions arrived at :—For the same consumption of water and fuel per hour, the work done by the compound engine is greater than that done by the ordinary engine ; for the same boiler-pressure and the same speed, the increase of work done by the compound engine compared with ordinary engines diminishes in proportion as the total consumption of fuel and water increases.

Mr. Sandiford's experiments were made on two locomotives which had been sent into the shops for heavy repairs, both of them requiring new cylinders. One was arranged with two high- and two low-pressure cylinders, and the other with one high- and one low-pressure cylinder. The compounding of both locomotives was attended with economy in consumption of fuel, and they were decidedly more powerful than the original engines had been, whilst from the drivers' point of view they were not more complicated.

The views held by the members taking part in the discussion agreed generally with those of the authors of the papers as regards the benefits both of jacketing and of compounding locomotives.

After the close of the discussion, the members visited various works in and around London, amongst those most favoured being the Royal Mint, Lambeth Pottery, the Royal Small-Arms Factory (Enfield), the Royal Arsenal (Woolwich), Beckton Gas-Works, the Royal Victoria and Albert Docks, Tilbury Docks, and the Crossness Sewage-Works of the Metropolitan Board of Works.

PROGRESS OF CHEMISTRY AND MINERALOGY

M. FRIEDEL, President of the French Association which met recently at Nancy, gave an address on the progress of chemistry and mineralogy. After briefly referring to the ravages made by death amongst the founders of the Society, and to the prospect of its amalgamation with the Scientific Association of France, M. Friedel proceeded to remark that the progress of chemistry during a period of thirty years had been set forth with masterly clearness and attractive eloquence by the late M. Wurtz at the gathering held at Lille in 1874, and two years later at the Clermont Conference. The theoretical conquests resulting in the discovery of the brilliant coal-tar dyes, the reproduction of alizarin and the other colouring substances of madder, of vanilline (the odoriferous principle of vanilla), of indigo, of the tartaric and citric acids, &c., continue their progressive and pacific career.

The study of countless artificial compounds brings us daily nearer to the natural compounds that have not yet been reproduced, and the most important alkaloids, such as quinine and morphine, seem already almost within the scope of synthetical chemistry. The work that has been undertaken in their regard resembles that of architects engaged in raising stone by stone the plan of some edifice at once of intricate design and difficult access.

This plan once securely established, the reconstruction of the building itself will no longer lie beyond the power of those regular synthetic methods which are daily acquiring greater expansion. It will soon be a mere question of patience and intelligent work, and the time is approaching when quinine and morphine will be produced as readily as alizarin now is. Nay more, there is reason to hope that besides the natural alkaloids others will be obtained endowed with valuable therapeutic properties. While endeavouring to reproduce atropine, whose synthesis he afterwards succeeded in making, M. Ladenburg has obtained homatropine, which produces physiological effects sufficiently distinct to claim, side by side with its homologue, a place amongst the agents employed by oculists. Other less successful essays have also shown in the derivatives of quinoline that patients have perhaps been somewhat prematurely treated with agencies producing a vigorous and very special action on the organism.

If synthetic chemistry has a bright future, we shall also doubtless see the development of another branch of chemistry which has hitherto been comparatively neglected, after having been held in honour at the beginning of the century, and found in Braconnot, of Nancy, an able and devoted cultivator. M. Friedel referred to the research of direct principles, that is to say, of the chemical compounds which exist in animals and plants, and which may be extracted from them. Similar alternatives are often presented in the history of science, which proceeds with irregular leaps, as results from the very nature of things.

The separation of the direct or immediate principles had first to place at the disposal of chemists abundant materials of varied composition, in order to fix their attention on the complexity of organic substances. Then came the time to seek the laws determining their constitution, and now that these laws are sufficiently understood to establish the structure and functions of many of them, the more complete study of their transformations, the more accurate definition of some already determined, the certain discovery of many others still unknown, must attract further attention to the work of those who, like Braconnot, have made a special study of the natural products.

Mineral chemistry has at last succeeded, in the hands of a young and skilful naturalist, in obtaining the isolation of fluorine, which had been in vain attempted by so many other students.

This important result is again due to the process used by Davy for isolating potassium—the decomposing action of the pile. The essay had already been made, but under conditions in which this exceptionally active element reacted on the electrodes or on the vessels. M. Moissan's merit consisted in perceiving that the decomposition should be made at a low temperature, and in the happy choice of the substance to be subjected to the process of electrolysis—hydrofluoric acid made conductive by the addition of fluoride of potassium. In the gaseous current disengaged at the positive pole, crystallised silicium and boron burn at the ordinary temperature, iodide and chloride of potassium are decomposed, mercury and other metals transformed to fluorides, organic compounds carbonised or inflamed, while water absorbs the gas, yielding in its place ozonised oxygen. Thus is produced a large number of reactions, whose study promises a most interesting sequel to this brilliant discovery.

Physico-chemical research continues on its part to furnish means of investigation enabling us to penetrate more deeply into the very life of the chemical molecule, that is, those inner movements whose existence must now be admitted.

Spectroscopy, which has just yielded to M. Lecoq de Boisbaudran two new metals, reveals, by the comparison of the rays, a connection, which is assuredly far from accidental, between the various elements of the same family.

Thermo-chemistry, after having, in the hands of M. Berthelot and M. Thomsen, given the reason of most reactions, now approaches the study of isomeric bodies. M. Bouty's researches on the conductivity of the solutions of salts, and those of M. Raoult on the lowering of the freezing-point of the various solutions, seem to supply fresh means for determining the molecular weight of compounds.

But our attention must now be directed to mineralogy, a far less popular science than chemistry.

After being held in considerable esteem at the close of the last and beginning of the present century, when Werner's labours enabled mineralogists to describe and methodically classify the rich materials accumulated in collections, mineralogy lost its votaries according as it became more scientific. The immortal labours of Haüy, of Berzelius, and the chemical school, seem to have scared the amateurs, who probably saw in mineralogical collections little more than so many picturesque specimens distinguished by their diversified colours and fantastic forms.

Mineralogy presents the special character that it profits by the progress of chemistry and physics, for which it has itself often enough supplied the starting-point. Aiming especially at the description of crystallised minerals, it applies to this description methods which are afterwards profitably transferred to the domain of artificial products.

Thus it has given birth to crystallography, which establishes the laws determining the formation of crystals—those marvellous products of the mineral world in which Haüy recognises the regular aggregations of infinitely minute particles.

This regularity of structure, indicated at once by their outward form, has been confirmed by the study of their many physical properties, especially that of their action on light. From this study has been derived one of the safest and most fruitful processes by which the inward architecture of crystals has been revealed. This consists in examining their action on polarised light, that is, on light which, by reflection or refraction under suitable conditions, has acquired special properties, and become incapable of being reflected or refracted like ordinary light, except under certain well-defined conditions.

To use a somewhat crude comparison, the luminous ray, after traversing certain media, assumes the appearance of an iron rod that has been passed through a rectangular drawing-frame. If on leaving the frame it meets an opening of like form and size, it will pass through without difficulty; but if the opening be placed crosswise, it can no longer pass.

There is this difference between the rod and the ray—that in all the intermediate positions a portion of the latter will pass through, the quantity increasing according as a more parallel disposition is assumed. Hence, if we take two apparatus corresponding to the frame and the opening, one of which supplies the polarised ray and the other intercepts it at right angles, the result will be complete darkness on the field of the instrument. But if we now place between both a crystalline plate of some substance which does not crystallise in the cubic form, we shall generally see the dark field illumined and often assuming the most lovely colours—an effect due to an action discovered by Arago and explained by Fresnel. With a homogeneous crystal, and when the light falls in parallel pencils on the plate, a uniform tint is diffused over the whole field of the instrument. If the crystal be not homogeneous, but formed of diverse parts jointed or regularly grouped together, but in positions not parallel, we shall get different tints for the different parts. By turning the crystal round, certain coloured strands will be extinguished, as we say, that is, will cease to transmit the light, while others will remain luminous. Hence we have here an extremely delicate and accurate means of studying the structure of crystals in their most intimate details. Haüy had already remarked that all crystals are doubly refracting, except those belonging to the cubic system. Brewster soon after thoroughly established the relation that exists between the optical properties and crystalline symmetry, stating, amongst other points, that cubic crystals alone have no action on polarised light. Nevertheless, observation had shown that certain substances affecting the cubic form had such action, and illumined the obscured field of the polarising apparatus. Biot had even suggested a term to designate, if not to explain, this exception, calling it "lamellar polarisation."

To the researches of M. Mallard we are indebted for the true account of this anomaly, which in fact he has explained away. He shows that the cubic crystals acting on the polarised light are not really cubic, but formed by the regular grouping of parts belonging to other crystalline systems. Boracite, for instance—chloroborate of magnesium usually taking the form of rhombic dodecahedra, that is, a solid of twelve equal rhombs belonging to the cubic system—is formed by the union of twelve straight pyramids with rhombic bases, whose summits unite in the centre of the crystal, and whose bases are the rhombic facets.

M. Mallard's beautiful experiments with parallel rays have been confirmed by those of M. Emile Bertrand with convergent rays, showing in isolated portions of the garnet and of boracite all the properties belonging to regular crystals of orthorhombic substances.

There can be no doubt as to the correctness of the explanation given by M. Mallard of the optical anomalies of crystals which had been regarded as cubic, but which have once more served to illustrate the trite remark, "Trust not appearances."

The optical investigation of crystals, due mainly to the late M. de Senarmont, has become a familiar process which no mineralogist can henceforth afford to neglect.

These same methods, employed with much greater magnification than in Amici and Nörremberg's primitive appliances, also render the greatest services to the geologist in the study of rocks. They enable him to determine with an otherwise unattainable accuracy the minutest elements of these formations, in which minerals are intermingled in diverse proportions. After Sorby, the pioneer in this line of investigation, Zirckel and Rosenbusch in Germany, Fouqué and Michel Lévy in France, have turned to the best account the new method, which has thrown much light on the origin and mode of formation of certain rocks, by showing what substances were first solidified and what parts resisted longest the cooling process.

All these determinations are aided by the study of the optical sign of crystals—that is, the relative velocity with which the two polarised rays are propagated in certain directions—the observation of the position of the axes wherever possible, that of dichroism, and even the approximate measurement of the indices of refraction.

This last has been much facilitated by an instrument recently devised by M. Emile Bertrand. With a transparent or opaque plate of some crystallised substance, and by means of not more than four readings made in two positions of the crystal, we obtain, by the determination of the angle of total reflection, the two or three indices, and consequently the wave-surface of the crystal for all bodies not having too high an index of refraction. And these operations, hitherto impracticable except with prisms or plates of great size, may now be made on extremely small crystals, such as those of rocks.

But however paramount the importance of optical properties, others also claim attention in crystallo-physics. Although of less practical interest in the determination of crystals, they may still open up many new avenues of inquiry to the physicist.

The curious property possessed by some hemihedral minerals of becoming charged with electricity with contrary signs at the two extremities of certain axes when heated or chilled has long been known. MM. J. and P. Curie have now shown that compression on the same crystals acts like the cooling, depression or traction like the heating process. In both cases the phenomenon appears due to the greater proximity or distance of the molecules. It is remarkable that the phemonenon may be reversed, so that hemihedral crystals with inclined facets properly charged with electricity, positive at one and negative at the other extremity, will contract or expand as the case may be.

As regards synthetic mineralogy, it is now known, thanks mainly to the researches of Berthier, Becquerel, Senarmont, H. Sainte-Claire Deville, and Daubrée, that minerals may be reproduced in our laboratories, and that we already possess a valuable means of study, enabling us to understand the conditions in which the natural minerals and their compounds may have been produced. We are thus advancing towards a chemical knowledge of certain species, whose formula analysis alone has failed to establish, and it may even soon be possible to produce useful substances under the very form from which they derive their properties.

The observation of the crystalline products accidentally formed in the metallurgic furnaces first led to this line of study, the firstfruits of which Mittscherlich and Berthier obtained by fusion.

By melting certain silicates, certain rocks or substances with the same chemical composition, and then exposing this vitreous mass to a temperature somewhat lower than that of fusion, MM. Fouqué and Michel Lévy have succeeded in reproducing the identical minerals found in lavas, basalts, and other eruptive rocks. Such are the anorthite and labrodorite feldspars, amphigene, pyroxene, peridot, magnetic iron, &c.

The case is otherwise with the granites, the problem of whose origin is far more difficult to solve. Nevertheless, of their three constituents two have already been artificially obtained.

Quartz had long ago been reproduced by Senarmont by heating gelatinous silica with a solution of hydrochloric acid to about 300° C. But Hautefeuille was the first to obtain fine crystals of orthoclase and albite feldspars by heating silica with alumina and the necessary alkalies in presence of a solvent such as a fused alkaline vanadate or tungstate.

But the conditions of this beautiful experiment do not appear to have been realised in nature. The nearest approach to them was probably the series of essays made by our President jointly with M. Edmond Sarrasin, by heating a solution of alkaline silicate with a precipitated silicate of alumina to nearly 500° C. in a strong steel tube lined on the inside with platinum. According to the alkalies and proportions employed, the result is albite or orthoclase mixed or not with quartz, the crystals resembling those occurring in nature and presenting the same peculiarities of form and grouping. The well-ascertained presence of drops of water in the granitic quartz seems to show that these granites must have been formed in the presence of aqueous solutions. Thus the natural conditions have already been approached, but will not be entirely realised until the hitherto recalcitrant mica has been obtained.

The first essays at reproducing the zeolite group of minerals have been made by De Schulten, who, by heating the silicate of soda in tubes of aluminous glass, has procured small icositetrahedra of analcime, such as occur in the lavas of the Cyclops Islands.

As regards precious stones, the solution of the problem from the scientific, if not the economic, standpoint, was long ago given for spinel and corundum by Gaudin, Ebelmen, H. Sainte-Claire Deville, and Caron. More recently, MM. Frémy and Feil have prepared the ruby in large crystalline masses unsuitable for cutting, although possessing all the properties of the natural mineral.

Fresh essays seem to have led to more practical results, as for some time past rubies of fair dimensions are met with in the trade, which, although rather less brilliant and transparent, possess the hardness, density, and optical properties of this valuable gem. Several features of their inner structure show conclusively that they were obtained by fusion; in any case it is well known that, unlike silica, which remains vitreous, alumina crystallises by fusion.

The diamond alone appears to have hitherto resisted all attempts at reproduction. Although success in this direction has been frequently announced, the statement has always proved erroneous. The problem is rendered more difficult from the fact that the diamond has nowhere been found in its original lode. This holds good as well for the Brazilian itacolumites and quartzites, and for the serpentine breccias of South Africa, as for the diamantiferous sands. Nevertheless, in the diamond are occasionally embedded some foreign substances, which, while depreciating its commercial value, are very interesting as showing that it must have been formed at a relatively low temperature.

But enough has been said, M. Friedel concluded, to enlist your interest in mineralogy, a science whose progress has been rapid, whose methods are being constantly renewed, and which in every respect deserves the attention of inquiring minds.

SCIENTIFIC SERIALS

American Journal of Science, August.—On hitherto unrecognised wave-lengths, by S. P. Langley. The object of the laborious and delicate operations here fully described has been, not so much to settle the theoretical questions involved in determining the relation between dispersion and wave-length, as to enable future observers to determine the visible or invisible wave-lengths of any heat, whether from a celestial or terrestrial source, observed in any prism. A knowledge will thus be gained of the intimate constitution of radiant bodies, which an acquaintance with the vibratory period of their molecules can usually alone afford. These researches into the whole unexplored region of infra-red energy both from celestial and terrestrial sources have led to the certain determination of wave-lengths greater than 0·005 mm. Radiations have also been recognised whose wave-length exceeds 0·03 mm., so that, while the wave-length known to Newton has been directly measured to nearly eight times, there is probable indication of wave-lengths far greater. The gulf between the shortest vibration of sound and the longest known vibration of the ether has thus in some measure been already bridged over.—On the chemical composition of herderite and beryl, with note on the precipitation of aluminium and separation of beryllium and aluminium, by S. L. Penfield and D. N. Harper. The composition of herderite is shown to be an isomorphous mixture of $CaBeFPO_4$ with $CaBe(OH)PO_4$, which may be written $CaBe(FOH)PO_4$, or a salt of phosphoric acid, two of whose hydrogen atoms have been replaced by a bivalent element, and the third also by a bivalent element whose other free affinity has been satisfied by a fluorine atom or hydroxyl. Chemically it is closely related to wagnerite, triplite, and triploidite, these minerals offering the best illustration of the isomorphism of F and OH. In crystallisation, herderite is orthorhombic, with a prismatic angle of nearly 120°. Regarding water as an essential constituent of beryl, the authors add $\frac{1}{2}H_2O$ to its usually accepted formula, writing it $H_2Be_6Al_4Si_{12}O_{37}$. Its theoretical composition, according to this formula, becomes SiO_2 65·81; Al_2O_3 18·83; BeO 13·71; H_2O 1·65. Specific gravity, 2·706.—Communications from the U.S. Geological Survey, Division of the Rocky Mountains, by Whitman Cross and L. G. Eakins. The present paper deals with ptilolite, a new mineral occurring in cavities of a more or less vesicular augite-andesite, which is found in fragments in the Tertiary conglomerate beds of Green and Table Mountains, Jefferson County, Colorado. It is described as a white substance in extremely delicate tufts and spongy masses composed of short hair-like needles loosely grouped together; hence its proposed name of ptilolite, from the Greek πτίλον = *down*, in reference to the light downy nature of its aggregates. Its empirical formula is $RO,Al_2O_3,10SiO_2 + 5H_2O$, R representing Ca, K_2, and Na_2; it is thus an alumino-silicate of which no previously described hydrate contains so high a percentage of silica. In this respect it may compare with the rare mineral milarite.—Notes on the peridotite of Elliot County, Kentucky, by J. S. Diller. This formation, described as a dark greenish rock with specific gravity 2·781, appears to be undoubtedly of eruptive origin, traversing many thousand feet of palæozoic strata to reach the surface. Its mineralogical composition shows 40 per cent. of olivine, 30·7 serpentine, 14 dolomite, 8 pyrope, 2·2 ilmenite, 2 magnetite, with smaller quantities of biotite, enstatite, octahedrite, and apatite.—Temperature observations at the Lake Superior Copper-Mines, by H. A. Wheeler. The unusually low thermal gradients recorded in these mines—about 1° F. to 100 feet as compared with the normal of 1° F. to 50 or 55 feet in vertical descent, is attributed to the proximity of the cold waters of Lake Superior. The nearer the mines are to this great cooling influence, the lower the thermal gradient will be found to be.—An application of the copper reduction test to the quantitative determination of arsenic, by Henry Carmichael. Using a standard square of copper as an indicator, the author has been led to adopt the method here described, which, for the estimation of small quantities of arsenic in the human system or elsewhere, he believes to be quicker, simpler, more delicate, and, in the hands of toxicologists, less exposed to fallacy, than any other. A copper square 1 millimetre on a side detects ·0000025 grm. arsenious oxide, a quantity 400 times less than that necessary for turning the beam of the ordinary chemical balance.—On the crystallisation of gold, by Edward S. Dana. The paper deals more especially with the delicate crystalline threads and arborescent forms from the White Bull Mine, Oregon, and the specimens of finely crystallised gold from the Californian mines. The crystals are illustrated and fully described.—Classification of the Cambrian system of North America, by Charles D. Walcott. The formations here treated are those characterised by the predominance of the types of Barrande's "First Fauna," and such additional strata, not characterised by the presence of fossils, as are stratigraphically and structurally connected with the Cambrian strata identified by organic remains. These formations, showing a total thickness of over 18,000 feet, with a known fauna of 92 genera and 393 species, are regarded, not as a subdivision of the Silurian, but rather as a well-defined geological system underlying the Lower Silurian (Ordovician) on the North American continent.—Note on the spectrum of Comet *c*, 1886, by O. T. Sherman. When observed with the equatorial of Yale Observatory in May and June, this comet presented no less than seven loci of light where three only are usually seen. These showed approximate wave-lengths 618·4, 600·6, 567·6, 553·7, 517·1, 468·3, and 433·2, besides strongly suspected loci at 545·4, 535·0, 412·9, and 378·6. These are compared with the low temperature spectrum of carbohydrogen, and it is suggested that a chart should be prepared for the carbon compounds at successive heat-levels, after the manner of that drawn up by Lockyer for the photographed spectra of some carbon compounds (*Proc. Roy. Soc.*, xxx. p. 463).

Annalen der Physik und Chemie, Bd. xxviii., No. 7, July 1886.—Th. Schröder, experimental investigation of the influence of temperature upon elastic reaction. The experiments were made with three wires, respectively of silver, iron, and german silver. The elastic reaction was greatest with the first, least with the last of these, and the change in the elastic reaction produced by change of temperature followed the same order.—E. Warburg, remarks on the pressure of saturated vapour. Discusses relation between vapour-pressure and curvature of liquid surface.—W. Fischer, on the pressure of saturated vapours above liquid and above solid substances. The substances chosen were ice and water. The difference, for ice, between the two differential coefficients of pressure with respect to temperature for saturated steam over ice and saturated steam over water is 0·0465, at the melting-point, where the two curves meet. For benzol the two curves do not meet at its melting-point.—A. Schrauf, on dispersion and axial density in prismatic crystals; and on the properties of trimetric crystals. The latter shows the existence of a relation between coefficients of expansion, axial density, and the parameters of the crystal.—A. Toepler, some lecture experiments on waves. A small gas flame is used to show the propagation of a wave of compression in a long tube filled with air, and provided at one end with an india-rubber pear. Several interesting experiments can be shown.—E. Cohn and L. Arons, conductivity and dielectric constants. An investigation as to whether the dielectric constant of a conductor is infinite, as often stated in text-books. A condenser was arranged to be filled with mixtures of anilin and benzol, xylol, mixtures of anilin and xylol in various proportions, &c., liquids being selected to avoid as far as possible residual charges. The capacities of this condenser were compared with that of an air-condenser, and arrangements were also made to measure the resistances on the bridge. The resistances of the three mixtures of anilin and xylol were 224,900, 1,383,000, and 18,780,000 Siemens's units, and their dielectric constants 1·590, 1·443, and 1·336. The authors conclude from these and other experiments that there is no necessary relation between the two constants; and, further, that the wide differences observed by Hopkinson between the square root of the dielectric constant and the index of refraction in certain vegetable oils cannot be explained by the conductivity.—E. Hoppe, on the theory of unipolar induction: experimental verification of Edlund's theory of the origin in terrestrial magnetism of auroral phenomena.—H. Jahn, on the equivalence of chemical energy and current energy. A discussion of Helmholtz's theory of the secondary heat of a voltaic element.—H. Jahn, on galvanic polarisation. A study of changes of polarisation of certain liquids with changes of temperature, together with deductions verifying Helmholtz's equations.—G. Adler, on the energy of magnetically polarised bodies.—E. Ketteler, addendum on the total reflection of crystals.—F. Koláček, on the gold-leaf spectroscope. An attempt to calculate a calibration of the electroscope from its electrostatic capacity.

THE number of the *Nuovo Giornale Botanico Italiano* for April 1886 contains a number of short articles on various points relating to the flora of different parts of Italy, both phanerogamic and cryptogamic.—Sig. A. Mori describes and figures a singular instance of the production of a pitcher-like structure on the upper surface of a leaf of *Gunnera scabra*.—Dr. O. Mattirolo has examined the "mycorhiza" of the roots of the sweet chestnut, and finds it to furnish a new example of polymorphism among the Hypocreaceæ. It consists largely of two species of fungus, which he names *Melanospora stysanophora* and *M. Gibelliana*. The former is identical with *Stysanus Steminotis* and also with an *Acladium*, and presents an instance of "apandry," or the production of ascospores independently of the previous formation of a male organ. *M. Gibelliana* produces chlamydospores, and also the peculiar structures known as "spore-bulbils," which appear to replace the true ascophorous perithecia.

The most interesting article in the number for July is by Sig. A. Piccone, on the plants growing wild in Liguria which he terms "zoophilous" or "ornithophilous," *i.e.* those which are absolutely dependent for the germination of their seeds on the fruit being swallowed by birds.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, August 4.—Prof. J. O. Westwood, M.A., F.L.S., in the chair.—The following gentlemen were elected Fellows:—Lord Dormer, Messrs. J. H. A. Jenner, James Edwards, Morris Young, F. V. Theobald, E. A. Atmore, and William Saunders, President of the Entomological Society of Ontario.—Mr. Theodore Wood exhibited and made remarks on the following Coleoptera: an abnormal specimen of *Apion pallipes*; a series of *Langelandia anophthalmi*, from St. Peter's, Kent, taken in decaying seed-potatoes; a series of *Adelops wollastoni*, and *Anommatus 12-striatus*, also from decaying seed-potatoes; and a series of *Barypeithes pellucidus*, from the sea-shore near Margate. Mr. Wood also exhibited, on behalf of Dr. Ellis, of Liverpool, a specimen of *Apion annulipes*.—Prof. Westwood exhibited five specimens of a species of *Culex*, supposed to be either *C. cantans* or *C. lateralis*, sent to him by Mr. Douglas, who had received them from the Kent Water-Works. It was stated that they were very numerous in July last, and that persons bitten by them had suffered from "terrible swellings." Prof. Westwood also exhibited some galls found inside an acorn at Cannes in January last.—Mr. Billups exhibited a male and female of *Cleptes nitidula*, taken *in copulâ* in July last, at Benfleet, Essex, on the flowers of *Heracleum sphondylium*. He stated that it was probably the rarest of the twenty-two known species of British *Chrysididæ*, though it had been recorded from the New Forest and from Suffolk.—The Rev. W. W. Fowler announced that a series of specimens of *Homalium rugulipenne* had been received from Dr. Ellis, of Liverpool, for distribution amongst Members of the Society.—Mr. White exhibited a group of three specimens of *Lucanus cervus*, consisting of a female and two males. The female was *in copulâ* with one of the males, which, while so engaged, was attacked by the second male.—Mr. E. A. Fitch read a paper, communicated by Mr. G. Bowdler Buckton, on the occurrence in Britain of some undescribed *Aphides*.—Prof. Westwood read a paper on a tube-making homopterous insect from Ceylon.—Mr. Theodore Wood read a paper on *Bruchus*-infested beans. A discussion ensued, in which Prof. Westwood, the Rev. W. W. Fowler, and Messrs. Weir, Fitch, and Trimen took part.

PARIS

Academy of Sciences, August 16.—M. Fizeau in the chair.—The Secretary announced the loss sustained by the Academy in the death of M. Laguerre, Member of the Section for Geometry, who died on August 13 at Bar-le-Duc. At the obsequies, which took place on August 16, the Academy was represented by M. Halphen.—Remarks on the recent volcanic disturbances in the Northern Island, New Zealand, by M. Emile Blanchard. The author pointed out that this sudden display of igneous activity was a remarkable confirmation of the views already advocated by him in 1882 and 1884 on the subsidence of an austral continent during the modern geological age of the earth. He regarded the New Zealand Archipelago and more or less adjacent islands as a remnant of this continent, or at least of an extensive region, which had existed in a comparatively recent epoch, and he had already, in 1884, anticipated fresh convulsions, such as the tremendous catastrophe of which New Zealand had been the scene after a lengthened period of quiescence. Tarawera and other volcanoes supposed to be extinct have suddenly broken out into fresh activity; lava-streams have overspread vast spaces, and a romantic tract of country, the delight of the early explorers, has been wasted or swallowed up. Although the exact change that has taken place in the aspect of the land cannot be fully known for some time to come, the event already appears as an illustration of still more violent outbursts, which occurred in more or less remote ages. Thus it has been shown in this instance that the inductions drawn from a recently-created science already bear the character of certainty.—On the differential equation of a curve of any order, by Prof. Sylvester. It is shown that a direct and universal solution may be had of the following problem: To find the differential equation of a curve of the order n, where the function of the equation (with unity for constant term), whether U or $(x, y, 1)^n$ is represented under the symbolic form u^n, where $u = a + bx + y$. It is added that the formulas given by M. Halphen in his "Recherches des points d'une courbe algébrique plane," &c., lead to the same results as those here arrived at.—On the employment of intermittent light for the measurement of rapid movements, by M. Gustave Hermite. Indicators of velocity at present in use always absorb a portion of the force of the machine to which they are applied. The author proposes to avoid this inconvenience by the arrangement here described, which, by an ingenious application of intermittent light, enables the observer to measure not only the number of revolutions of any machine, but the velocity of any rapid movement whatsoever, without exercising any mechanical action on the apparatus under examination.—On the mono-substituted haloid derivatives of acetonitril, by M. Louis Henry. The researches undertaken by the author on the functional solidarity and the volatility of the carbon compounds have led him to complete the series of these derivatives. Here he describes mono-ioduretted acetonitril, ICH_2—CN, and monobromuretted acetonitril, $BrCH_2$—CN, reserving for a future communication the comparative study of the mono-substituted haloid derivatives of acetonitril and acetate of methyl.—On the composition of the mineral waters of Bagnères-de Luchon, Haute-Garonne, by M. Ed. Willm. It is shown that carbonic acid, far from being a negligible quantity in these and similar waters, as was supposed by the late M. Filhol, mostly occurs in a proportion more than sufficient to give a quantity of bicarbonates corresponding to the alkaline property of the water, independently of that which is due to the sulphuret. A complete analysis yielded sulphuric and carbonic acid, chlorine, silica, ferric oxide, aluminium, sodium, potassium, calcium, magnesium, and traces of iodine, lithium, copper, ammonia, manganese, phosphoric and boric acid, but no arsenic.—Priestley's experiment repeated with aquatic animals and plants, by M. N. Gréhant. The experiment here referred to consists in placing under an air-tight vessel small mammals, such as mice, until the atmosphere becomes vitiated by the absorption of oxygen and liberation of carbonic acid; then, if a sprig of mint be introduced and the vessel exposed to the sun, after a certain time a mouse again introduced will breathe and live freely, the carbonic acid having been decomposed by the chlorophyll under the influence of the light and replaced by oxygen. An analogous experiment is here described with fish, and the leaves of an aquatic plant (*Potamogeton lucens*) introduced into receptacles filled with water.—Atmospheric phenomena observed at Palermo during the recent eruption of Etna, by M. A. Riccò. These light-effects are compared with those following the eruptions of Krakatão and Ferdinandea, their less brilliant character being attributed to the smaller quantity of vapours discharged by Etna.—The telluric currents, their nature, and the part played by them in the production of meteorological phenomena, by M. J. J. Landerer. In this paper, which is supplementary to the communication made to the Academy on October 17, 1881, the author gives the further results of the studies which he has now prosecuted for several years at Tortosa on the telluric currents and their various relations to terrestrial magnetism, the trade-winds, the solar spots, and the like.

BERLIN

Chemical Society, June 21.—A. W. Hofmann, Vice-President, in the chair.—Prof. Scheibler described in a long and very interesting paper his new methods of obtaining a product rich in phosphorus from the crude slag produced in Thomas's process. Whilst formerly the slag was extracted with dilute hydrochloric acid, and a precipitate rich in phosphorus obtained by adding lime to the solution, the present price of hydrochloric acid rendered it desirable to simplify the process. It was at first attempted to do this by a fractional solidification of the fused slag, the portion first solidifying containing little phosphoric acid, whilst the liquid portion separated from it furnishes an excellent material for manure. An essentially better method consists in adding the lime to the iron, not all at once, but first of all about two-thirds of the necessary quantity; the slag produced is then removed, the remainder of the lime added, and the process completed. The first lot of slag obtained in this way contains about 31 per cent. phosphoric anhydride, and 58 per cent. lime, whilst the second lot contains but little phosphorus, though it is rich in iron, of which it contains 24 per cent., the first slag having only 1·8 per cent. The second slag is returned to the furnaces used in the production of crude iron. The advantages of the method are a shortening of the blowing operation, the possibility of increasing the charge, a more complete removal of the phosphorus, less loss of iron, and considerable saving of lime. Further advantages are that the first portion of the slag forms a valuable manure, whilst the second portion is used again in the furnaces. The paper concludes with a discussion of the importance of this more complete separation of the phosphorus from iron ores for agricultural purposes.—W. Will exhibited an aromatic ketone obtained from the root of *Pæonia Moutan*, and which has been more closely examined by Prof. Nagai, of Japan. Its composition is

$$C_6H_3\begin{cases}COCH_3 & (1)\\ OH & (2).\\ OCH_3 & (4)\end{cases}$$

—There were two papers by J. Traube: (1) on the size of maximum-drops of the ordinary alcohols and fatty acids, and their aqueous solutions; and (2) on the dependence of the size of drops on external influences.—K. Polstorff has found that East Indian holarrhena contains conessine, and he considers that this alkaloid is identical with Haines's wrightine.—K. Heumann and E. Mentha have studied the behaviour of monochlorazo- and hydrazobenzene to acids; the latter yields chlorazobenzene, parachloraniline, and aniline.—Piutti has obtained a new asparagin from vetch sprigs; its aqueous solutions are dextrorotatory, and its compounds have the same rotatory power as the corresponding compounds of ordinary asparagin, but the rotation is always in the opposite direction.—T. Salzer described a new method of obtaining pentathionic acid by oxidising a solution of sodium thiosulphate with iodine in the presence of potassium arsenite.—M. Lange described a new synthesis of mixed azo-dyes from aromatic diamines.—G. Ciamician and P. Silber have studied the action of pyrroline on alloxan, and have described the properties and derivatives of pyrrolalloxan, $C_8H_7N_3O_4$, which results from the reaction.—J. Schmid showed that the colouring-matter of fisetwood (*Rhus cotinus*, L.), is not identical with quercitine, and that it is present in the plant as a glucoside (*fustin*); he described the preparation and the ethyl- and acetyl-derivatives of fisetin.

STOCKHOLM

Geological Society, April 1.—Prof. W. C. Brögger gave an account of the volcanic rocks extending between Langesund, in the Christiania Fjord, and Lake Mjösen, in Central Norway, founded on earlier and his own researches, the latter extending over many years. He had come to the conclusion that the whole basin was due to an erosion of the earth's crust, which had forced up the volcanic matter. The oldest of these, the augite porphyry, had been discharged in the form of lava streams over the Devonian surface of the earth. The more recent ones had not reached the surface, but had hardened at lower depths, and had become disclosed at a later date.—Herr A. E. Törnebohm described the remarkable coal-bearing rock which was discovered by Igelström some twenty years ago in the crystalline slates of the fundamental rock at the Nulla Mountain, in the province of Värmland. His microscopical researches went to show that the coal had been introduced into the rock whilst the formation of feldspar was still in progress.

BOOKS AND PAMPHLETS RECEIVED

"Proceedings of the American Association, 34th Meeting" (Salem).—"Quarterly Journal of Microscopical Science," August (Churchill).—"Proceedings of the Linnean Society of New South Wales," 2nd series, vol. i. part 1 (Cunningham, Sydney).—"Journal of the Royal Microscopical Society," August (Williams and Norgate).—"British Petrography," part 7, by J. J. H. Teall (Watson, Birmingham).—"Political Science Quarterly," vol. i. parts 1 and 2 (Ginn and Co., Boston).—"Avifauna Italica," by E. H. Giglioli (Firenze).—"Journal of the Asiatic Society of Bengal," vol. lv. parts 268 and 269.—"Annual Report of the Department of Revenue, Settlement, and Agricul ure, 1884-85" (Madras).—"Schriften der physikalisch-ökonomischen Gesellschaft zu Königsberg i. Pr."—"Pond Life: Insects," by E. A. Butler (Sonnenschein).—"Papers in Inorganic Chemistry," by G. E. R. Ellis (Rivingtons).—"Report on the Meteorology of India in 1884" (Calcutta).—"Indian Meteorological Memoirs," vol. iii. part 1, vol. iv. part 1 (Calcutta).—"Bergens Museums Aarsberetning, 1885" (Bergen).

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