THURSDAY, JUNE 4, 1896.

TWO BOOKS ON ELECTRICITY AND MAGNETISM.

Elements of the Mathematical Theory of Electricity and Magnetism. By J. J. Thomson, M.A., F.R.S., Fellow of Trinity College, Cambridge, and Cavendish Professor of Experimental Physics in the University of Cambridge. Pp. vi + 510. (The Cambridge University Press, 1895.)

Elementary Treatise on Electricity and Magnetism, founded on Joubert's "Traité Élémentaire d'Électricité." By G. C. Foster, F.R.S., Quain Professor of Physics in University College, London; and E. Atkinson, Ph.D., formerly Professor of Experimental Science in the Staff College. Pp. xix + 552. (London: Longmans, Green, and Co., 1896.)

PROF. THOMSON'S book will do good in many ways. Even its title will correct a wrong impression which very generally prevails, to the effect that just so much of the fundamentals and facts of the subject as can be discussed with the aid of a smattering of geometry and algebra, constitutes the truly elementary theory of electricity. On the contrary, students will find that the phrase *Elements of Electricity and Magnetism* really means that satisfactory grounding in essential ideas and their relations which is only possible to a student whose mathematical education has been or is being made adequate to the study of the higher parts of electricity. No important part of the subject is omitted, and of course this brings into play here and there mathematical processes more recondite than some which many practical men seem to shrink from. But there is no obtrusion of purely mathematical discussion; the analysis arises just where it is wanted, to the extent to which it is wanted, and goes no further.

A feature of the book which strikes the reader at once is the use made of the idea of Faraday tubes of force, or rather of electric induction in a dielectric. The distribution of these in the field in different cases of electrification is very fully described and illustrated graphically. This is a matter of very great importance. The examination of students supposed to have received a sound training in elementary electricity has convinced us that very few have a really clear notion of the actual nature of the electrification of a conductor in presence of external and internal charges. Of the dependence on the internal system of charges of the amount and distribution of the charge on the interior surface, and of the nature of the effect of the external system on the distribution on the exterior surface, they seem frequently to have no notion whatever, though they talk glibly about Faraday's ice-pail experiment and his "living" within the large tin-foil covered cube he made and electrified.

A very good elementary account is given of the subject of electric images, and several important particular cases are discussed; for example, that of two unequal spheres intersecting at right angles. This is then converted into the useful problem of the effect of a small hemispherical boss on the capacity of a large sphere.

The effect of dielectrics in the field is then considered, the method of electrical inversion introduced, and the usual problems of mutually influencing spherical surfaces solved. An excellent characteristic of this part of the book, as indeed of the work as a whole, is the working out of clearly formulated expressions which, on insertion of the proper numerical data, give at once the absolute values of important electrical quantities.

What we have said as to the clearness of the discussion of electrostatic theory applies also to the treatment of magnetism and the steady flow of electric currents. The treatment of electrolysis strikes one as rather meagre, but all the statements made are concise and to the point. The table of electrochemical equivalents on p. 282 stands in need of revision, the decimal point seems misplaced in one or two of the numbers.

In the discussion of the magnetic action of currents, Prof. Thomson applies elementary methods successfully to the determination of the magnetic fields of simple systems of currents, and might possibly have gone further in the same direction. But this chapter, the long one which follows on electromagnetic induction, and the thirteenth, which treats of dielectric currents and the electromagnetic theory of light, are the most interesting and important in the book. The first two of these deal with the phenomena and their quantitative expression, the last discusses the production of a magnetic field by the motion of Faraday tubes, Maxwell's theory of the propagation of electromagnetic disturbances, and the verification of this theory by experiment. To show the extent and thoroughness of the discussion, we may mention that the concentration of a rapidly alternating current near the surface of a conductor is explained by general considerations derived from the flow of heat, and, what is still better, is illustrated quantitatively by the case, which is fully worked out, of alternating currents induced in an infinite mass of conducting material bounded by a single plane face, beyond which in the insulating medium the inducing system is situated. This leads to a comparison of the distances to which currents sensibly penetrate in different metals, such as copper and iron, which lie widely apart as regards magnetic permeability.

An account, necessarily of course very short, but good so far it goes, is also given in the chapter on the "Dimensions of Electrical Quantities," of the absolute determination of resistance and the comparison of units. The method of the revolving coil and that of Lorenz are all that are described in the former case, and Maxwell's bridge method (employed so successfully by Prof. Thomson himself in conjunction with Mr. Searle) of finding in electromagnetic units the capacity of a condenser, and thus finding a number for comparison with the electrostatic value, is alone given in the latter case.

Here as elsewhere the author does not shrink from the introduction of a differential equation and its solution. The only alternative is the insertion of the result without proof. The inclusion of the necessary analysis, if it can be done without undue prolixity, is not, as it frequently seems to be regarded, an introduction of "useless mathematics." The justification of the result ought always to be indicated. If the reader cannot understand the proof, he can pass it over; its presence may serve to remind him that besides the mere results there is something more to be apprehended and appreciated—the theory by which they have been obtained.

In the chapter on the "Dimensions of Electrical Quantities," the author introduces besides μ and K a third constant p, which may arise in connection with the relation between the current and the magnetic intensity at any point in the field produced, so that 4π times the current flowing through a closed path in a magnetic field is equal to p times the work done in carrying a unit pole once round the path. The dimensions of this constant are of course unknown, and it is only by assuming its dimensions to be zero that the ordinary dimensions of current in electromagnetic units are obtained. There does not seem any distinctly physical ground for bringing in this constant p. The work done in carrying a pole in a complete circuit round a current is independent of the nature of the medium, and hence, justifiably so far as we can see, it may be taken as unity, without involving any neglect of the physical properties of the medium.

The method of the motion of Faraday tubes of electric induction is used in the chapter on "Dielectric Currents and the Electromagnetic Theory of Light." Perhaps it is possible to make too much of this conception; but there can be no question of its great utility as a means of keeping before the mind of the reader the idea of electric and magnetic action as taking place in the medium, and visualising, as it were, what takes place when a condenser is joined to another and partially discharged, when a current flows in a circuit, and the flux of energy in the medium which accompanies all such changes, whether constant or rapidly variable.

The commendation which the work of Prof. J. J. Thomson thoroughly deserves is the due also of that which Prof. Carey Foster and Dr. Atkinson have based on the elementary treatise of M. Joubert. This work has been recast so as to bring it thoroughly into accordance with the later views of electrical theory, and there can be no question of the entire success with which the English authors have performed their task. The book is a thoroughly sound and practical treatise. In it too, though not to the same extent, for its aim is different in some degree, there is a good deal of fairly advanced theory, and like the former work, it shows no shirking or glossing over of difficulties. It contains a more detailed account of the experimental details of the subject than the other work, and this, by the use of a somewhat small but still perfectly clear type, is got in without unduly swelling the volume. The two books read together would form an excellent combination. They are enough to give any competent student a most desirable acquaintance with the essential parts of the main phenomena, and their elementary theory. Such a student would afterwards go easily and rapidly forward with the study of the more elaborate theoretical works, and of the researches which have lately advanced electricity so much—the absolute determinations of electrical constants which have been made by so many experimenters, and the improved science of electrical measurement which these, together with the experimental investigation of the electromagnetic theory of light, and the vast development of practical electricity, have brought into existence.

A. GRAY.

ANNALS OF THE CALCUTTA BOTANIC GARDEN.

Annals of the Royal Botanic Garden, Calcutta. Vol. v. Part I. Pp. 9 + 68, 101 plates. (Calcutta: the Bengal Secretariat Press, 1895.

THE Royal Botanic Garden, Calcutta, has been publishing from time to time a series of "Annals," illustrative of the flora of the continent of India, the adjacent islands, and the contiguous countries. Volume v. of this work was published last year, and Part I consists of "A Century of Indian Orchids" by the chief of contemporary botanists, Sir Joseph Hooker. The Calcutta Garden has had the advantage of the services and labours of a long series of eminent botanists. Volume v. of the "Annals" is dedicated to perhaps the most distinguished of them, Roxburgh, superintendent from 1793 to 1814, and author of the "Plants of the Coromandel," the "Hortus Bengalensis," and the "Flora Indica," of whom a portrait and a brief memoir are prefixed. It may be well to recall the names of Roxburgh's successors to show how well botany has been served in connection with these gardens. They have been Wallich, Falconer, Thomson, Anderson, Clarke, and King; the last named, an admirable administrator and a distinguished botanist, being still in charge.

Since Roxburgh's time, that is for more than a century, what Sir Joseph Hooker describes as a "magnificent series of Indian plant-portraits by native artists" has been accumulating in the Calcutta Botanic Garden, of which about a thousand are those of orchids.

"The most important of these collections," says Sir Joseph ("Flora of British India," vol. v. p. 176) "were Malayan, abounding in novelties from Penang, Perak, Singapore and Malacca, made by the late Father Scortechini, . . . by Kunstler (a collector sent from the Calcutta Botanical Gardens by Dr. King), by Curtis Hullett, Wray and Ridley. Important collections were also sent by Mann from Assam, Bhotan, and the Khasia Hills; by Gamble from various parts of India; by Duthie from Garwhal; by Clarke from Sikkim, the Khasia Hills, and Bengal, together with a few from Central India; and by Dr. Trimen from Ceylon."

So little accessible were these drawings, and so little was their value known, that it was not until Sir Joseph Hooker had almost completed, as he mentions in his brief preface to the "Century," the descriptions of Indian orchids for his monumental work, the "Flora of British India," that he obtained, through Dr. King, the loan of the native drawings referred to. Sir Joseph further states that "the inspection of these drawings," coupled with the study of other material received from Calcutta, "necessitated a revision of the characters of the greater portion of the species already described, . . . together with the addition of not a few new species."

With reference to these drawings, the author states that, excellent as they are in many respects, they betray "that tendency to enlarge, which is the besetting sin of Indian botanical artists." Perhaps it is rather the indifference to exact accuracy—a strongly-marked characteristic of all Indian artists—which is in fault. No one who has had to do with Indian workmen can have failed to notice how difficult it is to induce them to recognise the importance of accurate measurements and proportions.

Now that so much attention is devoted to orchids in the gardens of Great Britain, and that their cultivation is, comparatively speaking, well understood, the publication of such a volume as the "Century" by our great botanist is a valuable help, not only to botanists, but to gardeners. Although all accessible parts of India have been searched through and through by experienced collectors, it is nevertheless a fact that comparatively few of the plants comprised in the "Century" are known to be in cultivation. Take, for example, the beautiful genus *Dendrobium*, of which so many charming species adorn orchid houses. Eighteen species of the genus are figured and described in the "Century," of which but one is to be found in Veitch's "Manual of Orchidaceous Plants," the best and most complete book on the subject. Even in the recently published "Hand-List of Orchids cultivated in the Royal Gardens" at Kew, there are mentioned but four out of the eighteen. There is an unfortunate tendency among orchid growers to view with scant favour the vast number of beautiful, delicate and interesting *small* orchids. An examination of the plates in the "Century"—which, by the by, are somewhat coarsely coloured—must prove that there are numerous genera and species well worth care and cultivation, even though they may not be as showy as a *Cattleya* or an *Odontoglossum*

Among the more striking of the plants figured in the "Century" are *Dendrobium crocatum* (Hook. f.), with its brilliant orange-coloured flowers; *D. Williamsoni* (Reichb. f.); *D. leonis* (Reichb. f.), with its remarkable imbricated leaves, and exquisite scent of vanille; *Cirrhopetalum gamosepalum* (Griff.); *C. refractum* (Zoll); and *Eria obesa* (Lindl.), with its clusters of spindle-shaped bulbs. Among others the following would be valuable additions to collections from a horticultural point of view—viz. *Acanthephippium striatum* (Lindl.); *Phaius Mishmeensis* (Reichb. f.); *Calanthe herbacea* (Lindl.), a very handsome plant growing in the Sikkim Himalayas, at an altitude of from 4000 to 6000 feet; *Eulophia* (*Cyrtopera*) *nuda* (Lindl.), figured in four varieties, of which the variety *purpurea* is the most distinct; *Eulophia* (*Cyrtopera*) *macrobulbon* (Hook.); *Sarcanthus insectifer* (Reichb. f.), a remarkable and exceptionally bright-coloured species from the Chittagong Hills; and several fine species of the genus *Habenaria*.

As the botanical descriptions in this work are from the pen of Sir Joseph Hooker, it would be presumptuous to praise them. Notes are appended to nearly every description, giving the habitat of the plant, the height above the sea at which it was found, the name of the discoverer where known, and other particulars.

As few of these beautiful and interesting orchids are even mentioned in manuals and lists of cultivated orchids, there is evidently still a wide field for orchid collectors, even in easily accessible parts of the British Empire and the neighbouring countries. And who knows but that the zeal of some collector working in the country north of the Bay of Bengal, might be rewarded at any moment by a re-discovery of that rare gem among slipper orchids, *C. Fairrieanum!* There has been but one importation, in 1857, of this elegant and graceful plant. "Its blossoms," says the late Sir William Hooker, "are certainly among the most exquisitely coloured and pencilled of any in this fine genus." It comes from Assam or Bhotan, countries well within reach; but probably has a very restricted habitat, and a station remote and difficult of access. Still the commercial value of an importation would be so great, that the zeal of importers and collectors ought not to cool until success crowns their efforts. The recent re-discovery of the habitat of the true *Cattleya labiata* (*autumnalis*), found by Swainson in 1818 on the Organ Mountains in Brazil, and lost sight of for over seventy years, is a case in point. May a like happy chance occur in the case of *Cypripedium Fairrieanum!* T. L.

OUR MINERAL INDUSTRIES.

First Annual General Report upon the Mineral Industry of the United Kingdom of Great Britain and Ireland for the year 1894. By C. Le Neve Foster, D.Sc., F.R.S. Pp. 144. Seventeen plates. (London: Printed for Her Majesty's Stationery Office, 1895.)

EVER since the year 1853 the position of the mineral industries of this country has been regularly recorded in an official volume, issued annually under the title of "Mineral Statistics of the United Kingdom." A series of these annuals, extending over nearly thirty years, was prepared under the direction of the late Mr. Robert Hunt, and issued from the Mining Record Office in Jermyn Street. For several years, however, two sets of returns were published concurrently—one set by Mr. Hunt, whose figures were obtained by the voluntary aid of mine-owners, and another set by the Inspectors of Mines, whose statistics were based upon statutory returns, and, consequently, came to be regarded as more trustworthy. To avoid the inconvenience of such duplication, the work of the Mining Record Office was taken over, in 1882, by the Home Office; and thenceforth there issued annually from this department a statistical volume as well as the ordinary Reports of the several Inspectors of Mines. These two publications have hitherto been the only official sources of information on mining published in this country. But something more was evidently wanted—something rather in the shape of a general year-book of mines and minerals. The publication of a comprehensive report of this character was suggested by the Royal Commission on Mining Royalties, and the suggestion was endorsed by the Departmental Committee on Mining and Mineral Statistics. At the request of the Home Secretary, Prof. Le Neve Foster undertook the preparation of such a report; and, considering the initial difficulties incidental to an undertaking of this kind, he is to be heartily congratulated on the work which he has produced.

After an introductory essay, explanatory of the various laws which regulate the working of minerals in this country, Prof. Foster deals with the statistics of the mining population. It appears that the number of persons employed underground in our mines during the year 1894 was 589,689, whilst those working in connection with surface-operations numbered 149,408; thus giving a total mining population of 739,097. The distribution of the underground workers in the various counties is represented on a coloured map, which shows at a glance that Durham and Glamorgan are the two counties with the largest number of miners. At the same time it must be remembered that, as the miners are not spread uniformly over any of the counties, the actual density of the mining population can never be accurately shown on such a map.

The total value of the minerals raised in each county is approximately indicated on another coloured map; and there are also maps showing the output, according to counties, of coal, iron-ores, lead-ores, and zinc-ores. The statistical maps and diagrams, which add greatly to the value of the Report, have been prepared mainly, we believe, by Mr. J. B. Jordan, whose experience in dealing with mineral statistics has extended over nearly forty years.

Among the diagrams is one showing graphically the annual output of coal and the quantity exported from 1860 to 1894, whilst a similar diagram shows the iron ore raised and the quantity imported for the same period. The annual production of the ores of copper, lead, tin and zinc, during a like period of thirty-four years, is also illustrated by special diagrams. Perhaps the most interesting of all the diagrammatic schemes are those dealing with accidents in mines. These tabular returns, extending from 1851 to 1894, suggest very melancholy reflections, but still it is matter of satisfaction to note that, on the whole, the miner's lot has been ameliorated. Prof. Foster, referring to a table of death-rates, points out that "mining has immensely improved in safety during the last forty-four years. The mortality from accidents has dropped and goes on dropping. From time to time disastrous explosions have caused a temporary rise, but on the whole there is firm and steady progress in the right direction" (p. 36).

Some two or three years ago a great improvement was effected in the "Mineral Statistics" by the introduction of brief descriptive notices respecting the mode of occurrence of the several minerals referred to in the returns. It is understood that these remarks were from the pen of Prof. Foster, and he has very properly reproduced them in this Report. So far as they go, they are models of concise description; but it is to be hoped that opportunity may be found, in some future work, for their amplification, for at present they rather whet the appetite than afford it full satisfaction.

A comparison of the mineral industries of this country with those of other lands, forming Part vi. of the General Report, must have involved an immense amount of labour, inasmuch as it necessitated the collecting and collating of the mineral statistics of the world. The statistical returns are accompanied by valuable descriptive remarks on the resources of each country; and with such thoroughness has this part of the work been done, that Prof. Foster adds notes in connection with countries, like Arabia, Egypt and Turkey, whence little or no statistical information can be procured. There are necessarily many gaps in the foreign statistics; but steps have been taken to secure fuller returns in future, and the subsequent reports will probably be less imperfect. Prof. Foster has prepared a form, in English and French, asking for specific data, and copies of this form have been issued, through the Colonial and Foreign Offices, to Her Majesty's representatives abroad.

Notwithstanding the care bestowed upon the preparation of the Report, and the evident desire to bring its information up to date, it still necessarily falls short, in some respects, of an ideal report on our mineral industries. The information, for instance, respecting stone obtained from quarries is only meagre; but the Quarries Act of 1894 will enable us in future to have statutory returns from all open workings, more than twenty feet deep. If the aid of a staff of specialists could be secured, the descriptive part of the Report might be advantageously expanded, and a volume produced something like that on the Mineral Resources of the United States, issued annually by the Geological Survey, or like the admirable work started a few years ago in New York by Mr. Rothwell. Even, however, in its present form, Prof. Foster's Report presents us with a record of the mineral industries of our country, far more comprehensive, instructive and accurate than anything which the British miner has hitherto possessed.

OUR BOOK SHELF.

Leerboek der Organische Chemie. By Dr. A. F. Holleman. (Groningen: J. B. Wolters, 1896.)

THE author in his preface says that text-books of organic chemistry, used in Holland by students of medicine and pharmacy and by candidates in the faculty of science, contain too much and too little—too many facts and too little theory.

There is no doubt that this criticism of our larger organic text-books is a fair one. Volumes like those of Richter and Bernthsen are distended with an unnecessary number of compounds, whilst they conceal within an occasional paragraph of small print important questions of theory; they are books for reference rather than for study. In the present case the author wisely attempts to minimise the number of compounds, and boldly discusses in full-sized type points of theoretical interest as they present themselves. The influence of the Amsterdam school of chemistry is very apparent in this.

We find accounts of geometrical isomerism, including Hantzsch and Bamberger's latest views on the constitution of diazo-compounds, of the relation between osmotic pressure and the freezing and boiling point of solutions, of Arrhenius' electrolytic dissociation theory and its application to the determination of the strength of acids, of the thermodynamic law, which underlies the conversion of racemates into tartrates, &c., all clearly and concisely given.

There can be little objection to physical-chemical theories entering into the composition of an organic text-book; they are interesting and suggestive. But the author has unfortunately fallen into the error of neglecting the practical side of the subject, of too frequently ignoring the laboratory and the works, of omitting experimental details of important preparations, and of presenting to the student chemical reactions as a series of ingeniously contrived equations.

We do not know, of course, for what type of student the book is intended; but it would be out of the question to put it into the hands of a beginner, or of one who had had no previous training in practical organic chemistry.

J. B. COHEN.

Physics for Students of Medicine. By Alfred Daniell, M.A., LL.B., D.Sc., F.R.S.E. Pp. 469. (London: Macmillan and Co., Ltd., 1896.)

DR. DANIELL'S "Principles of Physics" is known to be an excellent systematic treatise on physical science, setting forth fundamental principles in a sound and scientific way. In the volume now under notice the same orderly arrangement is followed as in its larger forerunner, the result being that the book provides a good general preparatory course, which will give students of medicine a broad and satisfactory view of the principles of physics, and will equip them with very serviceable knowledge. Intended primarily to meet the new regulations of the General Medical Council (which make physics a part of the extended course of professional study), the book contains numerous examples of the application of physical principles to medical science, relating both to instruments and muscular actions. But though medical students will find special interest in some of the examples used to illustrate the subjects described, the information given can readily be understood by all who read with studious mind. Therefore we commend Dr. Daniell's volume to teachers of physics generally, believing that they will find it worthy of adoption. The contents include chapters on units of measurement, motion of bodies, friction, matter, sound, heat, ether-waves, and electricity. All these subjects are treated as thoroughly as is possible in a book of this character.

Physics cannot be learned; it must be experienced. Dr. Daniell recognises this, and points out that his work "is not designed to supersede, but rather to clear the ground for practical teaching and demonstration." It is to be hoped that this practical work will some day form a part of the professional curriculum.

Physical Units. By Magnus Maclean, M.A., D.Sc., F.R.S.E. Pp. 147. (London: Biggs and Co., 1896.)

IT can safely be said that this book will find its way into every laboratory where physical facts are investigated. The tables of results brought together in the volume will be most useful for reference; and as they represent determinations made by foremost workers, trust can be put in them. Additional value is given to the tables by the fact that references are made in most cases to the books and papers from which the data have been obtained.

Two-thirds of the book are devoted to the discussion of physical units and the relations between them, the remaining third being taken up with the tables already mentioned. Students of physics will obtain from the text clear and sound knowledge of their units of measurement, and to more advanced investigators the book will prove a veritable vade-mecum.

Elements of the Theory of Functions. By Dr. H. Durége. Translated by George Egbert Fischer and Isaac J. Schwatt. Pp. 288. (Philadelphia, 1896.)

THE late Prof. Durége's treatise, in this English translation, will be a welcome addition to the works on this subject by Forsyth and Harkness and Morley. Durége has a genial method of exposition, as all who know his other book on Elliptic Functions will testify. The numerous definitions and novel ideas in the "Theory of Functions" are made clear by well-chosen illustrations and diagrams. There is no reference to the date of the first edition, but we believe it goes back some thirty years; so that Durége could claim to be a pioneer in the presentation of this subject to the general reader, Weierstrass's ideas being inaccessible to all except his own university pupils. G.

Charles Darwin and his Theory. By M. A. Antonovich. Pp. 353, with a portrait. (Russian.) (St. Petersburg, 1896.)

THIS is a very good summary of the chief works of Darwin, in which his scientific views are intimately interwoven with personal details of his life, in so far as they are known from Francis Darwin's "Life and Letters," and partly from Krause's "Charles Darwin," the whole being written with a deep admiration of both Darwin's personal qualities and his philosophy.

LETTERS TO THE EDITOR.

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

A Query concerning the Origin of Atolls.

HAVING recently visited and studied in some detail the coral mass of the Bermuda Islands, I have been impressed by one thing more than by anything else, namely, the fact so long known that the islands owe their present elevation almost exclusively to the action of the wind. The hills, which often rise to a height of 200–250 feet above the sea, from near their base to their summit, are made of blown coral sand, now consolidated into a more or less compact rock.

A recent subsidence has carried most of the islands below the sea level, leaving only the more elevated southern part above, because this had been built higher than the rest by the strong southern winds. This subsidence has been so recent that the heavy south waves are still battering at the cliff; and the débris thus obtained, added to that furnished by the abundant coral growth of the reef which lies immediately off shore, has not yet been able to build extensive beaches. Here and there we find beaches, usually small ones, and from these the sand is even now marching inland and adding to the height of the land, illustrating the process by which the islands have been reared to their present height. Nevertheless, although in a few places the importance of the wind action is still illustrated, it is practically at an end, and that because of a recent subsidence of certainly 50 feet and probably less than 100 feet.

On the basis of these facts I wish to propound a query which has arisen in my mind, but which I would not assume to answer on the basis of a study of only one coral island. Granting an atoll ring formed in the mid-ocean in the way which the theory supported by Dr. Murray and others demands, would we not of necessity have first a ring of reef or beach rock, then of coral sand which with age continued to rise in elevation until the Bermuda stage was reached? For various reasons a luxuriant vegetation would not at first serve to check this. A constant supply of sand is furnished by the life which skirts the shore, the waves are present to drive it on the shore, and the wind to heap it up.

Given this tendency and islands either standing at a uniform level, or being elevated, there should, it would seem, be all gradations between the atoll ring and the insular mass of wind-blown sand not unlike the Bermudas. If, however, the older theory advocated by Darwin and by Dana were correct, there would not need to be such a condition, for subsidence would counteract the action of waves and winds, and the ring condition of the low atoll could easily be the type condition.

Cornell University, Ithaca, N. Y. RALPH S. TARR.

"The Primary Factors of Organic Evolution."

IN a review of Prof. Cope's "Primary Factors of Organic Evolution" (NATURE, vol. liii. p. 553), Dr. Alfred R. Wallace denounces its "extraordinary statements," its "misstatements," and its "absurd arguments," and finds it refreshing to turn to the original ideas and acute reasoning of another book. The fact that the first book is by an opponent and the second by a follower of the reviewer, perhaps accounts for, though it does not justify, opinions that depart widely from what will be the judgment of the most competent. A work of unusual originality such as Prof. Cope's, is apt to contain much that is open to criticism; but it is no small matter to have brought together, as he has done, the evidence in favour of finding in the environment, in the movements of animals and in consciousness, the efficient factors of organic evolution. The present writer finds the arguments inconclusive, but he does not understand how any one can read the book without admiring the intimate knowledge of facts and the great powers of generalisation which it discloses. Dr. Wallace states that it is "absolutely untrue" that "the variation which has resulted in evolution has not been multifarious or promiscuous, but in definite directions," yet the evidence offered for this proposition—due perhaps more to Prof. Cope than to any other—has within the past few months proved convincing even to Prof. Weismann. Prof. Cope's book and his work should be adequately described and seriously criticised; but Dr. Wallace has done neither. J. MCKEEN CATTELL.

Columbia University, New York, May 9.

Barisal Guns.

IN reference to Sir Edward Fry's letter in NATURE for May 7, a fuller account of the mysterious sounds heard at Jebel Musa, and Jebel Nagus, in the Peninsula of Sinai, will be found in Palmer's "Desert of the Exodus," vol. i. pp. 217, 251. The former, which an Arab legend attributes to a fairy maiden, who fires off a gun one day in every year to give notice of her presence, "are," says the writer, "in all probability caused by masses of rock becoming detached by the action of frost, and rolling with a mighty crash over the precipice" (of 3000 feet) "into the valley below." The sounds at Jebel Nagus, which have also a legend connected with them, are undoubtedly due to the friction of rolling sand. From experiments made by the explorers, the degree of coarseness of the sand, the angle of inclination of the slope, and temperature, seem to be the controlling conditions.

B. W. S.

Hampstead, N.W.

THE SPERM WHALE AND ITS FOOD.

OUR fund of accurate knowledge of the Cetacea being at so low a level, it is to be deplored that trained scientific observers have hitherto had few opportunities for noting under normal conditions the habits of these most interesting animals. And therefore naturalists generally will certainly hail with delight the news of the resolution of the Prince of Monaco to endeavour by all the means at his disposal to make an effective study of that least understood of all the deep sea mammalia—the great sperm whale. An observer like Dr. Scoresby who, while gaining his livelihood by the pursuit of the Greenland whale, lost no opportunity of studying that monster's manners and customs for the benefit of science generally, is still to seek for the world-wide fishery of the cachalot. This may be said without in the least minimising the excellent work done by Surgeons Beale and Bennett, who remain almost the only first-hand authorities we have on the sperm whale. They were not in command, and were consequently at a great disadvantage for making observations; for the whole crew of a whaleship are co-partners in the venture, and the essential business of oil-getting must on no account be hindered, or there is trouble all around. And since their day, unfortunately, British shipowners have had little or no interest in the southern whale fishery, while none who know what a motley crowd constitute the crews of American whalers, will be surprised that no contributions to natural history come from that quarter. I am the more pleased, therefore, that in the course of my career as a seaman, it happened that I was induced some twenty-one years ago to join a whaleship in New Zealand for a long cruise in the Southern and Eastern seas. All the average sailors' usual ignorance of the differing characteristics of different whales was mine; but so interesting did I find the study of these great denizens of the deep sea, under my extended acquaintance with them, that I seized every chance I could obtain to learn whatever I could of them, without any idea at the time of putting the knowledge so gained to any practical use. The first occasion worthy of note here was also my initial encounter with a cachalot. We were cruising the wide stretch of ocean in the South Pacific known as the "Vasquez" grounds, and sighted a small pod of sperm whales, mostly sprightly young cows, under the guardianship of two or three immense bulls. We lowered four boats, and very soon the boat in which I happened to be "fastened" a medium-sized cow, who promptly returned the compliment by rising bodily beneath the boat and ripping the bottom out of it with her hump. Of course our connection with that whale was at once severed, the task of keeping our heads above water, with our boat hardly more than a bundle of loose planks beneath us, being amply sufficient to occupy all our energies until we were rescued. In the meantime the second mate had successfully harpooned and slaughtered another and much larger whale very near to us—so near, in fact, that we weltered in a gory sea lashed into foam by the monster's dying struggles.

Just before she died, we noticed her in the act of vomiting, and several masses of the matter ejected floated all around us. Some of them were exactly like large blocks of blanc-mange of no particular shape, almost white, but in some instances spotted with various colours. Many of the smaller pieces, however, were unmistakably portions of tentacles; lengths bitten or torn off. These it was most easy for me to identify, even under the awkward conditions, having been long familiar with the leaping or flying squid so often picked up on deck during heavy weather, or taken from the stomachs of albacore (*Scomber thynnus*), bonito (*Thynnus pelamys*), or dolphin (*Coryphæna hippuris*). This peculiar sight, although witnessed under such difficulties, made a very definite impression upon me, and as I had always examined the contents of the stomachs of such fish as I caught, so I longed to eviscerate the captured cachalot for a like purpose, although it was evident that she had probably ejected all the food that her maw had contained. Such anatomical pursuits are, however, quite out of the question at sea in a whaleship. Those who would essay the tremendous task of disembowelling a whale while it floats beside the ship, might indeed be rewarded by a find of ambergris worth more than the whole of the blubber and spermaceti, but the chances are not sufficiently inviting to tempt whalemen to undertake such herculean labours in addition to the already heavy toil of "cutting in."

Long afterwards, while cruising in Foveaux Straits, we caught a gigantic cachalot—the largest I think I have ever seen, even in that haunt of monstrous whales. We had an easy capture, for our prize had been previously attacked by some other ship, and in various parts of his body were the *disjecta membra* of seven exploded bomb-lances. Hardly was he fast alongside when one of those furious westerly gales so common on the southern shores of New Zealand sprang up, and it was well indeed for us that we had a good port under our lee. In spite of the load we had to tow, we arrived in Port William early the next morning with our prize all safe, and at once proceeded to cut him in. While engaged in this satisfactory, if filthy, operation, some Maories and half-breeds came off, and civilly asked if they might have the carcase when we had done with it. As it was of no earthly use to us, permission to take it when we cast it adrift was graciously accorded.

By dint of strenuous toil we got to the last joint of the vertebræ by 4 p.m., and, having disjointed it, the mountain of flesh floated majestically away, to be seized immediately by the waiting beach-men, who, with incredible labour, succeeded in landing the carcase near the western horn of the little bay.

That handful of men, six in all, laboured night and day for the best part of a week to get whatever oil was contained in the skeleton, bowels, and fat about the muscles. As we had finished our labour, a grand opportunity presented itself for examining the interior economy of this whale.

The vast cavity of the stomach contained a goodly assortment of cephalopoda in a more or less fragmentary condition; for I should have said that this whale, unlike most, had not ejected his food before his death. Judging from the sizes of the tails and the girth of some of the pieces, I estimated the largest of the squid at not more than six feet long, exclusive of the head. But what struck me as most peculiar was the large quantity of *bony* fish contained in the stomach of this cachalot. Blue and red rock-cod, groper, barracouta, and sea-bream were there—two or three bushels of them. Some were so recent as to be hardly soiled, and none bitten or damaged in any way except by digestive process.

How so vast and comparatively clumsy a creature could succeed in obtaining such a large supply of active fish is incomprehensible to me, except upon the supposition that in waters like these, where fish abound in such incredible numbers, the cachalot cruises gently about with the great lower mandible hanging down (its normal position). The fish, mistaking the great livid cavernous throat for a cave of another kind, enter therein, to find egress impossible. But this is only a pious opinion of mine, unsupported by evidence other than the presence of fish where none could reasonably expect to find them, except under some such circumstances as I have supposed.

On another occasion we were cruising between Tongatabu (Friendly Islands) and Futuna, or Horn Island. Just before sunset a solitary sperm whale of goodly size was harpooned by us, and immediately sounded to a depth of 500 fathoms. He remained below the surface for about forty minutes, so that when he broke water again it was nearly dark. Of the terrors of that night I might say much, but this is not the place, neither do I think if it were that I could do anything like justice to the subject. Sufficient then to say that his agility and vitality were unequalled by that of any whale that I have met with, and it was well into the small hours of the morning before he gave up the contest. When day dawned we found that his lower jaw was twisted at right angles to his body, the result probably of some terrific conflict in the long ago. The outstanding portion of the jaw was almost covered with limpets of massive appearance, some measuring six inches across the base, and the intervening spaces were filled in with fringing barnacles of great length, giving him the semblance of a hoary beard. This alone was sufficient to endow a creature of such normal ugliness with an uncanny prehistoric sort of look—and there were not wanting members of our crew to exclaim that this was surely Davy Jones himself. But the chief peculiarity about this cachalot, and, indeed, the reason why I mention him here at all, was the extreme hardness and dryness of his blubber. Under ordinary conditions a whale of his size should have yielded at least seventy barrels of oil, but owing, I suppose, to the difficulty he must have had to procure food, it was only with an extraordinary expenditure of labour that we succeeded in extracting from him thirty-two barrels of oil. The opinion of all on board competent to give one was, that being unable to cope with the big squid, owing to the loss of his great weapon, the lower jaw, he had been driven to seek support on such food as he could obtain, and only managed to exist in a state of semi-starvation. Doubtless this accounted for his agility, and his fine drawn body, more like that of one of the Balænoptera than of a cachalot, went far to confirm the idea.

And now I come to the final instance for the present paper, but by no means the least important, at least to my mind, since it has settled several vexed questions for me finally. We were cruising in the Strait of Malacca, between the Nicobars and the Malay Peninsula, and had succeeded in killing a full-sized sperm whale. He had been a tough customer, needing all our energies to cope with him ; but a well-directed bomb closed the negotiations just before sunset. As usual, he had ejected the contents of his stomach before dying, and we specially noticed the immense size of some of the masses floating about. By common consent they were about as large as our hatch-house, which measured 6 ft. × 6 ft. × 8 ft. I must very distinctly state that these masses were not square, but irregularly-shaped masses, bitten or torn off in blocks from the body of some gigantic squid.

The whale was secured alongside, and all hands sent below for a good rest prior to commencing to "cut in" at daybreak. I had the watch from eight bells to midnight, and at about 11 p.m. was leaning over the lee rail, idly gazing seawards, where the rising moon was making a broad lane of silvery light upon the smooth, dark waters. Presently there was a commotion in the sea, right in the way of the moon, and I immediately went for the night glasses to ascertain if possible the nature of it. In that neighbourhood there are several active volcanoes, and at first I judged the present disturbance to be one of these, sending up débris from the sea bed. A very short examination satisfied me that the trouble, whatever it might be, was not of volcanic or seismic origin. I called the captain, as in duty bound, but he was indisposed to turn out for anything short of actual danger, so the watch and I had the sight to ourselves. We edged away a little under the light draught of wind, so as to draw nearer to the scene, and presently were able to realise its full significance. A very large sperm whale was engaged in deadly conflict with a monstrous squid, whose far-reaching tentacles enveloped the whale's whole body.

The livid whiteness of those writhing arms, which enlaced the cachalot like a nest of mighty serpents, stood out in bold relief against the black boulder-like head of the aggressor. Presently the whale raised itself half out of water, and we plainly saw the awful-looking head of the gigantic mollusc. At our distance, something under a mile, it appeared about the size of one of our largest oil casks, which held 336 gallons. Like the rest of the calmar visible, it was of a peculiar dead-white, and in it gleamed two eyes of inky-blackness, about a foot in diameter. To describe the wonderful contortions of those two monsters, locked in a deadly embrace, is far beyond my powers, but it was a never-to-be-forgotten sight. The utter absence of all sound, for we were not near enough to hear the turmoil of the troubled sea, was not the least remarkable feature of this titanic encounter. All around the combatants, too, were either smaller whales or immense sharks, who were evidently assisting in the destruction of the great squid, and getting a full share of the feast. As we looked spell-bound we saw the writhings gradually cease, and the encircling tentacles gradually slip off the whale's body, which seemed to float unusually high. At last all was over, and the whole commotion had completely subsided, leaving no trace behind but an intensely strong odour as of a rocky coast at low tide in the full blaze of the sun. Since that night I have never had a doubt either as to the origin of all sea-serpent stories or the authenticity of the old Norse legends of the Kraken; for who could blame a seaman witnessing such a sight, and all unaccustomed to the close observation of whales, for reporting some fearsome monster with horrent mane and floating "many a rood." An interesting account of the French gunboat *Alecto* falling in with a calmar forty feet in length, lying on the surface in the North Atlantic, once fell into my hands. It told how those on board succeeded in getting a hawser passed round the creature, but in heaving it tight the rope cut its way through the soft gelatinous body, which floated away in halves, and gradually sank. I much regret now that I do not remember anything of the name or date of the publication in which this account appeared. In previous communications of my own to the press on the subject of sperm whales and their capture, I have incidentally alluded to these immense molluscs—*vide Land and Water*, September 29, 1894 ; *Chambers's*, March 24, 1894 ; *Pall Mall Gazette*, September 7, 1895 ; *Sheffield Weekly Telegraph*, November 2, 1895 ; *Good Words*, September 1895—a few of the most recent ones.

In closing these brief notes, owing to exigencies of space, I would like to add that the only place for accurate observations of these animals is at a bay-whaling station, such as the Prince of Monaco visited at Terceira. If he, with the appliances at his command, adheres to his resolve to pursue this great study, we shall soon be in possession of some splendid data. And he, or others on a similar errand, would find the best opportunities in the southern hemisphere, where the number of sperm whales are simply amazing around certain easily accessible spots.

FRANK T. BULLEN.

THE TORNADO.

THE exceptionally disastrous and destructive tornado which occurred at St. Louis, in the State of Missouri, shortly after five in the afternoon of May 27, draws more than ordinary attention to this class of disturbance, and excites, for a time at least, an interest in such phenomena. These disturbances are by no means of uncommon occurrence in the United States, but it is happily not often that a densely populated city falls directly in the track of the full fury of the storm.

Such well-known authorities as Ferrel, Finley, and Hazen have devoted much attention to tornadoes, and it is chiefly to the writings of these that we look for information. Several years ago the United States Signal Service published a report of the character of 600 tornadoes, and this clearly shows that no season of the year is exempt from their occurrence, but their greatest frequency is in the spring and summer, whilst in winter they are seldom experienced. Their occurrence is more common in April, May, June and July, than in any other months of the year. They almost always occur after the hottest part of the day, the hour of greatest frequency being between three and four in the afternoon, and they seldom begin after six in the evening. The centre of the disturbance is almost always formed in the southern or south-eastern segment of an ordinary area of low pressure, and a study of the weather charts, embracing a large area of the United States, shows that they are often several hundred miles from the centre of the parent disturbance. Those familiar with the formation and behaviour of our thunderstorm disturbances in England, will recognise an analogy to the tornado in their origin and motion with respect to the primary disturbance, of which they are mere secondaries. According to Finley, of the 600 tornadoes upon which he reported, the rotary movement of the whirling cloud was invariably from right to left, or the opposite movement of the hands of a watch. Ferrel remarks that this indicates either that the earth's rotation on its axis, as in cyclones, must determine the direction, or that the atmosphere has numerous whirls in this direction. The progressive motion of a tornado is almost always in a north-easterly direction, and here again there is a resemblance to the ordinary track followed by low-pressure areas in middle latitudes. The velocity of progression of the tornado cloud is said to vary from 7 to 100 miles an hour, the average rate being 44 miles. According to Finley the vortex wind velocities of the tornado cloud vary from 100 to 500 miles an hour, as deduced from actual measurements, and velocities of 800 to 1000 miles an hour have been reported. A wind velocity of 500 miles an hour is equal to about 750 lb. on every square foot. The width of the path of destruction, supposed to measure the distance of sensible winds on the sides of the storm's centre, varies from 40 to 10,000 feet, the average being 1085 feet, as deduced by Finley from a discussion of a large number of instances. The length of the tornado's track varies from 300 yards to about 200 miles, the average being 25 miles. The tornado has many features in common with the cyclone, but as experienced in the United States it is essentially different in many points, and in the interests of science it should be kept distinct. The tornado cloud assumes the form of a funnel, the small end drawing near or resting upon the earth, whilst the cloud and the air below it revolve about a central axis with inconceivable rapidity. Tornadoes differ from cyclones mostly in their extent, but both have vertical and gyratory circulations. A cyclone may extend over a circular area of one or two thousand miles in diameter, while a tornado rarely affects sensibly at any one time so great an area as a mile in diameter. In a cyclone the base is so great in comparison with the height, that the whole mass of gyrating air may be regarded as a thin disc, and consequently a large amount of the force is spent in overcoming the frictional resistances at the earth's surface. In a tornado the height is so great in comparison with the base that the gyratory velocity is almost wholly free from friction. The late Prof. Ferrel, who ranks probably higher than any other authority on winds and storms, was of opinion that a cyclone "requires, in addition to the state of unstable equilibrium for saturated air, such a disturbance in the general equality of temperature over a considerable area that there is a central and somewhat circular area of higher or lower temperature, from which arises a vertical, and consequently a gyratory, circulation"; while the tornado "simply depends upon conditions which give rise to very local disturbances merely." Without doubt the conditions which characterise the tornado are also common to such phenomena as waterspouts, cloudbursts, whirlwinds, wind-blasts, and others of a like nature

An excellent descriptive report of the St. Louis catastrophe appeared in the *Daily Telegraph*, and is abridged below. The report shows that the tornado had many features common to such disturbances. The occurrence of "three separate and distinct storms," which subsequently became one, is especially alluded to by Ferrel in his general description of tornadoes. He says: "As the tornado originates in air in the unstable state, it often happens that there is about an equal tendency in the air of the lower stratum to burst up through those above at several places in the same vicinity at the same time. Each of these gives rise to a separate and independent gyration in the atmosphere, and a small funnel where they are of sufficient violence; but generally, as they increase in dimensions and violence, they interfere with one another and finally become united into one." The reported wind velocity of eighty miles an hour appears to be an estimate formed outside of the central area of the storm. In England the wind has attained a velocity of 107 miles for a whole hour, registered at Fleetwood in the gale of December 22, 1894, and at Holyhead on February 20, 1877, the anemometer registered an hourly rate of 200 miles for a short time in the gusts.

The weather at St. Louis nearly the whole of Wednesday, May 27, was unusually warm and oppressive. There was not a breath of wind, and the people suffered greatly from the heat. About four o'clock in the afternoon the western horizon became banked with clouds piled one on top of the other, with curling edges tinged with yellow. The sight was beautiful, but somewhat terrifying. Then a light wind sprang up, followed by sudden and ominous darkness.

The gloom deepened, and when the storm actually burst upon the city pitch darkness prevailed. These strange atmospheric disturbances had created anxiety among the people abroad in the streets, but not alarm.

There seemed to be three separate and distinct storms. They came from the north-west, from the west, and from the south-west, but when these reached the river they had become one.

Before the great mass of menacing clouds which were hanging over the villages of Clayton, Fernridge, Eden, and Central gave forth their contents funnel-shaped formations shot out of them. Some of these funnels seemed to be projected into the air; others leaped to the earth, twisting and turning like some wounded monsters. Lightning played about them. There was, in fact, a marvellous electrical display. Then came the stupendous outburst.

From the great black clouds came a strange, weird, crackling sound, at times stronger than the incessant peals of thunder, which had from the first been a terrifying feature of the storm. The funnels enveloped the western side of the city, and within thirty minutes of their first appearance on the horizon they were dealing out destruction.

So irresistible was the storm in its power, and so much greater in its magnitude than any other previously recorded in America, that some of the staunchest business blocks in St. Louis, considered absolutely tornado-proof, went down before it as though they were mere barns. Iron girders were torn from their massive fastenings and carried blocks distant. Roofs that were braced and held by every device known to architects and engineers were wrenched off and hurled into the streets. The destruction of telegraph material was phenomenal. The poles were blown down in long rows, not singly, but in groups of a dozen or more at a time.

The western end of the Eads Bridge—admittedly one of the finest in the world—was destroyed. The same fate overtook other splendid bridges spanning the Mississippi.

The scene on the river at the moment the cyclone passed over it was awe-inspiring. The river tossed and boiled as though it was a whirlpool. Great waves struck the vessels and swamped them. Some steamers were blown bodily high up upon the banks, and others were twisted right round. Others, again, after being torn from their moorings disappeared in the torrent and were never more seen. As a rule the smaller craft did not live in the terrible sea for a minute, but just capsized and sank.

In the smaller places through which the tornado passed the terrible funnels rose and fell as they swiftly moved, and thus the line of destruction was not continuous. But whatever stood in their path was either destroyed or badly damaged, and all this destruction was done within the space of one hour.

About five hundred persons are reported to have been killed during the passage of the tornado, and more than seven hundred injured. The path followed is now shown to be a well-defined track about half a mile wide and four miles long.

NOTES.

THE second of the two annual conversaziones of the Royal Society, to which ladies as well as gentlemen are invited, will take place on Wednesday, June 10.

THE University of Paris will be represented at the forthcoming jubilee of Lord Kelvin, by MM. Moissan, Lippmann and Picard. The Royal Astronomical Society has appointed the President, Dr. A. A. Common, F.R.S., as its representative upon that occasion; and the Senate of the University of Sydney have appointed the Chancellor, Sir William Windeyer, and Prof. Liversidge, F.R.S., the Dean of the Faculty of Science, to represent them.

WE have referred from time to time to the approaching eclipse of the sun. During the last week some members of the expedition to Japan have sailed. From information received from the Japanese Minister, the reports of the bad weather chances at the station chosen are more than confirmed. The mean of the last five years gives for August—

	Days
Clear	0
Cloudy	22
Rain or snow	22

With regard to the Norwegian parties, Dr. Common will occupy a station at Vadsö, and in his neighbourhood will be Dr. Copeland. Mr. Norman Lockyer intends, if possible, to observe on the south side of Varanger fjord, if a suitable anchorage and observing station can be found sufficiently near the totality line. This point will be inquired into by Captain King Hall, of H.M.S. *Volage*, which will be detached from the Training Squadron for this purpose.

LIEUTENANT PEARY is making arrangements for another trip to Greenland, one of the objects being to bring back for the Philadelphia Academy of Sciences the forty-ton meteorite discovered by him last year, being the largest in the world. He will shortly give an account of his important explorations in Northern Greenland to the Royal Geographical Society.

THE Council of the British Medical Association desire to remind members of the profession engaged in researches for the advancement of medicine and the allied sciences, that they are prepared to receive applications for grants in aid of such research. Applications for sums to be granted at the next annual meeting must be made on or before June 15, in writing, addressed to the General Secretary, at the office of the Association, 429 Strand, W.C.

THE Commissioners of the proposed zoological park of New York City have selected as the site that portion of Bronx Park lying south of Pelham Avenue, comprising two hundred and sixty-one acres. It is expected that their selection will be approved. The site is near the new botanical garden, and New York City will thus acquire in this year ample zoological and botanical gardens and an aquarium.

PROF. N. L. BRITTON has been appointed superintendent of the new botanical garden of New York City.

THE death is announced of M. Raulin, Professor of Industrial and Agricultural Chemistry in the University of Lyons.

THE Paris correspondent of the *Times* announces the death, at the age of eighty-two, of M. Daubrée, the eminent geologist. Born at Metz, and educated at the Polytechnic School, Paris, he was sent on a geological mission to Algeria, and from 1839 to 1855 was a Professor at Strasburg University. He was then promoted to a chair at the School of Mines and the Natural History Museum, Paris. His experimental researches, on the action of rapidly moving and high-pressure gases on rock masses, and the application of the results to peculiar rock formations, are still fresh in the minds of every one interested in geological problems.

WE regret to notice the death of Sir J. Russell Reynolds, F.R.S., on Friday last, at the age of sixty-eight. He was educated at University College, London, where he became Professor of the Principles and Practice of Medicine in 1865. Four years later he was elected a Fellow of the Royal Society. He was President of the British Medical Association in 1895, in which year he also received the honorary LL.D. degree at Aberdeen, and recently a similar honour was conferred upon him by the Edinburgh University. On the death of Sir Andrew Clark, in 1893, he was elected President of the Royal College of Physicians, which post feeble health compelled him reluctantly to relinquish at the recent annual election. Sir Russell Reynolds' works on diseases of the brain and spinal cord are valuable contributions to medical literature, and the "System of Medicine," of which he was the editor, stands as a proof of his sound sense and good judgment.

THE forty-first annual exhibition of the Royal Photographic Society will be held from September 28 to November 12, in the gallery of the Royal Society of Painters in Water Colours. Negatives, transparencies, photo-mechanical prints, stereoscopic work, photographs of purely scientific interest, photographs coloured by scientific or mechanical means, and photographic apparatus will be admitted. Foreign exhibitors are invited to contribute photographs or apparatus. Exhibits must be received by the Secretary of the Royal Photographic Society, on or before September 9.

THE President of the Board of Trade has appointed a Committee, consisting of the following gentlemen, viz.:—Lord Blythswood (chairman), Sir Benjamin Baker, K.C.M.G., F.R.S., Sir J. Lowthian Bell, Bart., F.R.S., Prof. Wyndham Dunstan, F.R.S., Prof. A. B. W. Kennedy, F.R.S., Major F. A. Marindin, R.E., C.M.G., Mr. E. P. Martin, Prof. W. C. Roberts-Austen, C.B., F.R.S., Dr. T. E. Thorpe, F.R.S., Prof. W. C. Unwin, F.R.S., and Mr. E. Windsor Richards—to inquire as to the extent of loss of strength in steel rails produced by their prolonged user on railways under varying conditions, and what steps can be taken to prevent the risk of accidents arising through such loss of strength. Mr. W. F. Marwood, of the Board of Trade, has been appointed to act as Secretary to the Committee.

By the will of the late George Yeoman Heath, Professor of Surgery in the University of Durham, and President of the Durham College of Medicine, a sum of £200 is awarded every second year for a surgical essay. We learn from the *Lancet* that the second award will be given to the writer of the best essay on "Congenital Deformities, their Pathology and Treatment." All graduates in medicine or in surgery of the University of Durham are eligible to compete for this scholarship, and the essay, which must be type-written or printed, should be delivered to the trustees not later than March 31, 1898. The essay, together with any specimens, drawings, casts, microscopical preparations, or other means of illustration accompanying it, will become the property of the College, though by permission the essay may be printed for general circulation by the Heath scholar. This is one of the most valuable surgical prizes in the kingdom, and the competition should be keen.

The Société helvétique des sciences naturelles will hold its seventy-ninth meeting from August 2 to 5, at Zürich. This will be the sixth occasion on which the Society has met at that place, and it will do so very appropriately in August next, because the Zürich Société des sciences naturelles—the oldest of those existing in Switzerland—celebrates this year the 150th anniversary of its foundation. A number of papers have already been promised in the various sections into which the congress will be divided. All who desire to be present, or to contribute papers, are requested to communicate with the Secretary, Dr. Aug. Aeppli, Kinkelstrasse, Zürich IV., before July 15. The Swiss Societies of geology, botany, and entomology will meet at the same time as the Société helvétique des naturelles sciences. A geological excursion has been organised, under the direction of Prof. A. Heim, and there will also be a botanical excursion. Every one interested in the advancement and unity of science is cordially invited to attend the meeting.

At the Electrical Exposition in New York, a few days ago, messages were sent all round the world, and received back in a few minutes. A vast audience hailed with enthusiasm the return of the messages from their long circuits. The first surprise was the announcement that a message had been received within four minutes after sending it, having meanwhile twice crossed the continent of America and the Atlantic Ocean. At London the message was rewritten, and sent on to Tōkiō, and back to New York by a circuitous route, covering 27,500 miles in about fifty minutes. Another message, making another circuit of equal length, returned a few minutes later; while a message sent all round South America, came back in twenty-three minutes. The messages were dictated by Chauncey M. Depew, President of the New York Central and Hudson River Railroad, and Mr. Adams, President of the Niagara Falls Power Company. Mr. Edison received one or two of them. The messages will be preserved in the Smithsonian Institution, together with copies of all papers throughout the world that published them, so far as they can be obtained.

A slight shock of earthquake is reported to have been felt in West Cornwall, at five minutes to seven on Friday morning, May 29. An earthquake shock also occurred in Dumfriesshire, and a noise resembling a distant peal of thunder was heard. Furniture and crockery were agitated by the movement, which lasted a few seconds, and does not appear to have been attended by any damage of consequence.

It appears from the annual reports of the six Pasteur Institutes existing in Russia and Poland (St. Petersburg, Moscow, Warsaw, Odessa, Kharkoff, Samara, and Tiflis), that during the year 1892 no less than 2886 persons applied at the Institutes for anti-rabic treatment, as against 2976 in 1891. Out of them, 2763 persons were put under treatment. The percentage of deaths was, as usual, very high for wolves' bites, viz. from 2·22 to 37·5 per cent. in the different institutes; while for dogs' bites the percentage of deaths was insignificant, that is, from 0·5 to 1·05.

Among many articles of interest in the May number of the *Essex Naturalist*, is one by Mr. Henry Laver on "Potash Making in Essex: a lost rural industry." In the beginning of this century the preparation of alkali by the lixiviation, in large iron or copper pots, of the ashes of wood, straw, grasses, and other vegetable refuse, was a very common rural industry in Essex, the "pot-ash" thus produced being frequently converted at once into soap. The decay of this industry must be chiefly attributed to the production on the large scale of the cheaper soda-ash from salt, and to the introduction of coal instead of wood as fuel. Mr. Laver contrasts the healthful conditions under which the potash was produced a century ago, with those under which soda is produced at the present day; a contrast much to the disadvantage of the latter.

In the *Comptes rendus* for May 4, one of Maxwell's early proofs of the "error law" of distribution of velocity in the kinetic theory of gases receives severe criticism in the hands of M. J. Bertrand. In the work referred to, Maxwell claimed to have solved the problem of finding the law of distribution of speed in a system of molecules without making any assumptions as to the nature of these molecules or the forces between them beyond that, on account of the absence of all regular order, everything was distributed equally in all directions. After comparing Maxwell's problem to the favourite schoolboy question, "Given the dimensions of a ship, find the age of its captain?" M. Bertrand points out that the proof in question really involves a very important assumption, and one which he appears to regard as unjustifiable. If x, y, z be the velocity-components of a molecule in three directions at right angles, Maxwell states, or rather *assumes*, that the velocity x has no influence on the velocities y and z, their directions being independent, and hence that the number of molecules whose velocity-components lie between the limits $dx\, dy\, dz$ is represented by an expression of the form

$$N\, \phi(x)\, \phi(y)\, \phi(z)\, dx\, dy\, dz.$$

M. Bertrand considers that the x component *does* influence y and z, and that by neglecting this influence, which is great, Maxwell obtained a solution of an insoluble problem.

The kinetic theory also forms the subject of an article by Prof. Boltzmann in *Wiedemann's Annalen*, in which he attacks some views recently enunciated by Herr Zermelo. Prof. Boltzmann regards the Boltzmann-Maxwell Law as a theorem in probability, rather than a principle of abstract dynamics. There is nothing to preclude the *possibility* of the molecules of a gas behaving at any instant in a totally different manner from that indicated by the law, but the greater the number of molecules the more improbable does such a departure from the law become.

In the *Botanical Gazette* for April, an interesting case of mimicry is described, the seeds of the "Philippine island bean" from the coast near Manila, so closely resembling the quartz pebbles among which they fall, in shape, size, colour, lustre, hardness, and stratification, as to be indistinguishable from them except by a very close examination. The size and shape of the beans are both very variable, ranging from 10 to 23 mm.; some perfectly resemble well-rounded beach pebbles, while others mimic pebbles which have been broken across. Their colour varies from moderately dark to light drab, some giving a faint greenish tinge; others resemble pebbles of chalcedony or of crystallised quartz. Nearly all the specimens show a series of approximately parallel darker lines passing round, very suggestive of stratification. All are quite hard, cut only with difficulty with a knife, and give a clinking sound when shaken together in the hand. They are not affected by soaking in sea-water.

A MONOGRAPH of the *Crambidæ* (or grass moths) of North America, by Dr. C. H. Fernald, was issued by the Massachusetts Agricultural College in January of the present year. Much care seems to have been bestowed upon this essay, which extends to ninety-three pages, and is illustrated by three plates of details, and five coloured plates of quite unusual excellence, as well as occasional woodcuts.

THE interesting address on Meteorological Observatories, delivered by Mr. Richard Inwards before the Royal Meteorological Society, early in this year, is published in the April *Journal* of the Society, with illustrations of the Temple of the Winds, Athens, Greenwich Observatory, and Kew Observatory. Mr. Inwards has brought together a large amount of general information on meteorological observatories in various parts of the world.

THE report of the Marlborough College Natural History Society for 1895 has just been issued, and contains numerous articles, not only on local ornithology, entomology, botany and meteorology, but also on archæology, astronomy and chemistry. There are also illustrations of Wayland Smith's Cave, and of High Street, Marlborough, after the great storm of June 26, 1895. Times seem to have changed since classics and mathematics were regarded as the only subjects worth thinking about at a public school.

BY order of the Government of Madras, that Observatory has published a valuable series of daily, monthly, and yearly meteorological means, as a supplement to the volumes already issued giving the meteorological observations from 1796 to 1890. They are not intended as a discussion of those observations, but have been prepared specially for use in various offices which issue daily weather charts of Indian regions. The rainfall values extend over eighty years, and the barometrical means over fifty years.

WE have received the nineteenth report of the State Entomologist on the noxious and beneficial insects of the State of Illinois. It is the eighth report of S. A. Forbes, for the years 1893 and 1894 (1896); with a separately issued appendix on the Mediterranean Flour Moth (*Ephestia kuehniella*, Zell.) in Europe and America, by W. G. Johnson, Assistant Entomologist. These reports are drawn up in the usual elaborate American manner, and the main report is chiefly devoted to the Chinch Bug (*Blissus leucopterus*, Say) and to White Ants, and is illustrated with thirteen plates of a very miscellaneous character in connection with the ravages of these and other insects. Much attention is given in this report to experiments on the dissemination of vegetable parasites among insects.

THE latest number of the *Journal* of the Asiatic Society of Bengal (vol. lxiv. part ii. No. 3), contains articles of unusual interest and variety. Nearly three-quarters of the part are taken up with a list of the Butterflies of Sumatra, by Mr. De Nicéville and Dr. Martin; while Messrs. King, Prain and Pantling write on *Papaveraceæ*, new orchids from Sikkim, and on a new species of *Renanthera*. But in addition to these more technical entomological and botanical papers, Surgeon Lieut.-Colonel Ranking writes on artificial immunity to snake venom by inoculation or internal application, in ancient and modern times (compare Prof. Fraser's articles in recent numbers of NATURE); and Mr. Frank Finn commences a series of contributions to the theory of warning colours and mimicry, by recording his experiments in feeding a Babbler (*Crateropus canorus*) on protectively-coloured butterflies and other insects.

WE note the appearance of three new volumes in the extensive series which constitutes the Encyclopédie Scientifique des Aide-Mémoire, published by MM. Gauthier-Villars and G. Masson. One is the third volume on "Géométrie Descriptive," and it deals with changes of planes of projection, rotations, trihedrons, and polyhedrons. In "Calcul de Temps de Pose en Photographie," by M. H. Boursault, the complex problem of the conditions which affect calculations of the time of exposure is treated in a very satisfactory manner. Scientific photographers will find much exact and serviceable information in M. Boursault's little volume. A volume on "Les Tramways," by M. R. Seguela, is an account of methods and materials employed in the construction of tram-lines in France, the United States, Great Britain, and other countries.

THE volumes in Stanford's Compendium of Geography and Travel, now in course of reissue, have been subjected to such thorough revision and considerably enlargement, that they are practically new books. The work on Asia, for instance, first published in 1882 in one volume of 750 pages, has been expanded into two volumes of about 550 pages each, and the first, dealing with northern and eastern Asia, has just been published by Mr. Stanford. Mr. A. H. Keane is responsible for this volume, and he may be complimented upon the thoroughness with which he has performed his task of revision. If the forthcoming volume on southern and western Asia is as satisfactorily done as the one now published, the whole will form an admirable account of the geography of the Asiatic continent, and one which accurately records the results of the important expeditions made during the past few years.

RECENT events in the Transvaal have had the effect of increasing the number of visitors to the South African Museum, according to the annual report of the Trustees; and this connection is borne out by the fact that during January of the present year the number of visitors was 5574, three-fourths of which consisted of country people, while the other fourth consisted chiefly of new arrivals and inhabitants of the Cape Peninsula. Visits from the inhabitants of Cape Town are said to be comparatively rare. Several attempts were made during last year to procure some of the large South African mammals, but the Trustees have not yet been successful in obtaining specimens of the elephant, giraffe, hippopotamous, &c., to replace the defective ones in the Museum collection. A number of fossil remains procured by Mr. E. H. L. Schwarz from the Prince Albert district of the colony are being developed by him. Fragments of one of the fossil reptiles have been sent to Prof. Seeley for development and identification, and the animal has been provisionally named by him *Tetracynodon*. Reference is made in the report to the resignation of the Curator, Mr. R. Trimen, and the appointment of Mr. W. L. Sclater as his successor. We notice that on account of the increased requirements of the new Museum, the buildings of which were taken over by the Trustees at the end of last year, the annual subsidy has been raised from £1600 to £2000.

WE have received the meteorological results of the observations taken at the Bangalore, Mysore, Hassan and Chitaldroog observatories for the years 1893 and 1894. The stations were established by the Mysore Government, in accordance with the desire of the Government of India. In addition to the usual tables, the work contains diagrams giving the mean daily and monthly values of the various elements, and a map of the Mysore Province, showing the average annual rainfall for the twenty-five years (1870–1894). These diagrams exhibit at a glance the nature of the weather changes, much more easily than could be gathered from a mere collection of figures. They show clearly that the rise of temperature from the cold of January to the heat of March and April is much more rapid in Mysore than at Madras, where the climate is tempered by the influence of the sea. It is interesting to observe the interval between the mean dry and wet-bulb temperature throughout the year, and the daily range of temperature; the latter varies greatly, amounting to nearly 34° at Hassan, in January. The highest shade temperature in the two years was 99°·5 at Chitaldroog, in April 1893.

THE *Quarterly Journal* of the Geological Society for May is an unusually thick number, and its contents cover almost as wide a range of geological subjects as could be brought together. Palæontology is represented by the presidential address on the history of the Crustacea by Dr. Woodward, who also contributes papers on Cretaceous Crustacea from Vancouver, and on the only known fossil Octopod; while Mr. C. W. Andrews discusses the Plesiosaurian skull, and Mr. P. Lake continues his work on a group somewhat neglected of late years by British geologists—the Trilobites—with a study of the Silurian species of *Acidaspis.* In stratigraphy, Dr. Hicks contributes a paper in which he claims the Morte Slates as Silurian, and reopens in a new manner the North Devon controversy, while Miss Elles and Miss Wood show that there are Llandovery beds in the Conway district. The British Cretaceous rocks are subjected to a most detailed correlation—as regards the Speeton series by Mr. Lamplugh, and as regards the Cenomanian by Messrs. Jukes-Browne and Hill; the former author urging that some of the strata dealt with are strictly Jurassic, while the two latter show that the true Cenomanian of France represents our Lower Chalk only, and not our Upper Greensand. The only Tertiary geology in the journal concerns the Basaltic plateaus of North-western Europe and the river-system of the old land across which the lavas were poured, described in a most interesting paper by Sir Archibald Geikie. This last paper, along with one on a part of the same subject—the Skye granophyres—by Mr. Harker, represents also the petrological contributions to the journal. Important evidence is adduced by Prof. Edgeworth David of a Permo-Carboniferous glaciation of Australia. Finally, Prof. Hull's paper on the geology of the Nile, and Mr. Hill's, on transported Boulder Clay, must not be forgotten.

AN elaborate monograph on "The American Lobster," by Prof. F. H. Herrick, forming a part of the *Bulletin* of the United States Fish Commission for 1895 (pp. 1–252), has been issued as a separate publication. The memoir contains the results of a masterly study of the habits and development or general biology of the lobster, and is illustrated with the lavishness which is a feature of official publications of the United States. Until comparatively recent years the lobster was singularly neglected by naturalists; nevertheless, Prof. Herrick gives at the end of his memoir a list of more than two hundred papers referring to the Crustacea, of which the lobster may be styled the king. The subjects of the chapters in the present contribution to this literature are: habits and environment, reproduction, moulting and growth, defensive mutilation and regeneration of lost parts, large lobsters, enemies of the lobster, the tegumental glands and their relation to sense organs, variation in colour and structure, structure and development of the reproductive organs, habits of the lobster from time of hatching until the period of maturity, history of the larval and early adolescent periods, and embryology of the lobster. It will be seen from this brief statement that Prof. Herrick has studied many phases of the general biology of the lobster, and in all of them he adds to the previous knowledge of the subject. His observations are of scientific value, and many of the facts described, more particularly those relating to the larval development and reproduction, have important economic bearings. After some statistics pointing to the decline of the lobster fishery in the United States, Prof. Herrick remarks: "Civilised man is sweeping off the face of the earth, one after another, some of its most interesting and valuable animals by a lack of foresight and selfish zeal unworthy of the savage. . . . Thus, as we shall see, the American lobster occupies only a narrow strip along a part of the North Atlantic coast, and while it is probably not possible to exterminate such an animal, it is possible to so reduce its numbers that its fishing becomes unprofitable, as has already been done in many places. The only ways open to secure an increase in the lobster are to protect the spawn-lobsters, or to protect the immature until they are able to reproduce, or to take the eggs from the lobsters themselves, and hatch them artificially." For the sake of the persons engaged in the lobster fishery, it is to be hoped that measures will be taken in time to prevent its further decline in the United States.

THE additions to the Zoological Society's Gardens during the past week include a Caracal (*Felis caracal*) from India, presented by Captain E. F. Carter; a Spotted Cavy (*Cœlogenys paca*) from Trinidad, presented by Dr. F. G. C. Damian; a Common Otter (*Lutra vulgaris*), British, presented by Mr. Henry Laver; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mrs. Browning; a —— Deer (*Cariacus paludosus*, ♂) from Paraguay, two Green-winged Doves (*Chalcophaps indica*), two White-backed Pigeons (*Columba leuconota*) from India, four Alligators (*Alligator mississippiensis*) from the Mississippi, four Dandin's Tortoises (*Testudo dandinii*) from the Aldabra Island, deposited; two Thick-tailed Opossums (*Didelphys crassicaudata*) from South America, four Gouldian Grass Finches (*Poëphila gouldiæ*), two Crimson Finches (*Estrelda phæton*) from Australia, purchased; a Sœmmerring's Gazelle (*Gazella sœmmerringi*, ♂), two Striped Hyænas (*Hyæna striata*), an Egyptian Ichneumon (*Herpestes ichneumon*), two Libyan Zorillas (*Ictonyx lybica*), two Fennec Foxes (*Canis cerdo*), two Ruppell's Vultures (*Gyps rüeppelli*), four Egyptian Vultures (*Neophron perenopterus*) from Egypt, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE RING NEBULA IN LYRA.—The appearance of the brightest of the ring nebulæ, as seen with the Lick 36-inch refractor, is described by Prof. Barnard in *Ast. Nach.* No. 3354. The aperture of the ring was filled with a feebler nebulosity, which was estimated to be nearly midway in brightness between the brightness of the ring and the darkness of the adjacent sky. This aperture was more nearly circular than the outer boundary of the nebula, so that the ends of the ring were thicker than the sides. The following end of the ring had a slightly greater extension, which was less bright than the ring itself, and the entire nebula was of a milky colour. The central star was usually seen, but was never a very conspicuous object. The brightest region of the nebula lies in the northern part. Micrometric measurements of the nebula gave the following mean results:—

Position angle of major axis ...	65°·4
Outer major diameter	80″·9
Inner major axis	36″·5
Outer minor axis	58″·8
Inner minor axis	29″·4

A magnifying power of 520 was generally employed.

VARIABLE STAR CLUSTERS.—The discovery of a large number of variable stars in certain star clusters was announced a few months ago by Prof. E. C. Pickering (NATURE, vol. liii. p. 91). Since then a special investigation has been made of the variables forming part of the cluster M. 5 Serpentis, N.G.C. 5904 (*Ast. Nach.* 3354). Forty-five photographs of this cluster have been measured by Miss Leland, and the measures include the greater portion of the forty-six variables previously discovered. The periods of these variables are in general very short, not exceeding a few hours. One of these, designated No. 18, which follows the centre of the cluster about 6′ and is south 5′, has a probable period of 11h. 7m. 52s., or 0·4638 days. The coordinates of the light curve of this variable are as follows:—

Days.		Mag.	Days.		Mag.
0·00	...	13·50	0·25	...	14·73
0·05	...	13·87	0·30	...	14·73
0·10	...	14·35	0·35	...	14·72
0·15	...	14·70	0·40	...	14·65
0·20	...	14·72	0·45	...	13·56

It thus appears that the star remains about minimum brightness during half the period, while the maximum luminosity is of relatively short duration; the decrease in light is rapid, and the rate of increase still more rapid. The succession of changes does not seem to correspond with those of any previously known class of variable stars.

RECENT RESEARCHES ON RÖNTGEN RAYS.

THE novelty of Prof. Röntgen's skeletal photographs has almost worn off, and the field of research opened up by his observations is now mainly occupied by scientific workers, who are endeavouring to analyse the rays, and to extend the knowledge of their characteristics, rather than to produce startling pictures capable of exciting the wonder of the general public. But though the interest of scientific dilettantes has waned, the investigators who remain in the field are still so numerous that it is hardly possible to keep in touch with the multitude of observations published; and published in some cases, perhaps, a little prematurely. A number of interesting results have been recorded from time to time among our "Notes"; but so many papers and communications have been received during the past few days, that they are now brought together for readier reference, as has been done in several previous issues of NATURE.

Attempt to Polarise Röntgen Rays.

Dr. John Macintyre, whose observations on the capabilities of Röntgen rays have formed the subject of several letters and notes in these columns, has sent us an account of an attempt to polarise the rays. Different views have been expressed about the possibility of polarising the rays by means of tourmalines, and although Dr. Macintyre's experiments seem to indicate a negative result, they are of such importance that they deserve to be put on record.

The source of electricity was the main, and the measurements across the terminals (with Lord Kelvin's cell-tester and ampere gauge) were 10 volts and 10 amperes. The spark of the Rhumkorff coil was 6 inches, and a mercury interrupter was used. An ordinary Crookes' focus tube, enclosed in cardboard to exclude all light, was excited by the above, and the vacuum carefully arranged to give the maximum fluorescence by gently heating the bulb with a spirit-lamp. Screens of barium platino-cyanide, potassium platino-cyanide, and lithium-rubidium-platino-cyanide were tried. The two tourmalines were got as nearly alike as possible, the measurements of each being: length, 47 mm.; breadth, 12 mm.; thickness, 2 mm.; and the experiments were carried out in a dark room.

In the first experiment, on placing one tourmaline between the source of the Röntgen rays and the screen, and directly in contact with the latter, a distinct shadow was seen due to absorption of the rays. On placing the second tourmaline parallel with the first, a difference in density of the shadow was immediately observed. When the tourmalines were gradually turned at right angles to each other, a dark square area could be seen where the two crossed. A source of error was, however, suggested in this experiment. One of the tourmalines could not be in as close contact with the screen as the other; and on account of the manner in which the Röntgen rays pass from a point on the platinum plate in such a Crookes' tube, differences were observed in the shadows of the four arms of the cross formed by the tourmalines. For example, (1) if the horizontal tourmaline were next to the screen, and the vertical one behind it, the two arms above and below the square dark central area were less sharply defined than the two arms on each side of it, and consequently the shadows appeared to be different. (2) Although on the square portion corresponding to where the tourmalines crossed, one got a darker shadow still, it might only be due to the difference in thickness of the two layers.

A second observation was then made. One of the tourmalines was broken in two portions, and one of these was placed parallel with and the other perpendicular to the other tourmaline. Again the dark square area was seen by direct vision. Dr. Macintyre could not say, however, that the density was greater than where the other portion of the broken tourmaline was laying parallel with the whole one. This rather suggested that the square dark area was caused by difference of density only. In a third series of observations photographs were taken with different exposures —one with a single flash of the tube, due to one interruption of the coil; others with much longer exposures, but in all the same difficulties in distinguishing between the two conditions arose. (Copies of these photographs have been received from Dr. Macintyre.) In the first photograph a shadow of one tourmaline was obtained, proving the absorption of some of the Röntgen rays. In the second photograph, of one whole tourmaline and a portion of the other, a greater density can be noted where two layers are lying parallel with each other than where only one tourmaline interferes with the rays. The third photograph shows the unbroken tourmaline covered at one part by a portion of the broken tourmaline lying parallel with its axis. The other part of the broken tourmaline is placed at right angles, and Dr. Macintyre raises the question whether the density of the square area is greater than where the two tourmalines are lying parallel with each other. In his opinion, the photographs bear out the observations by direct vision, and appear to give negative results; and an examination of the two photographs which form the result of his crucial experiment, leads us to conclude that there is not any appreciable difference of brightness between them.

Röntgen Rays and the Resistance of Selenium.

Mr. J. W. Giltay, Delft, Holland, has sent us the following important communication on the influence of Röntgen rays upon the resistance of selenium.

Some weeks ago, the possibility of Röntgen rays having an influence on the resistance of selenium occurred to me. I made a preliminary experiment to put this idea to the test, but, probably owing to the poor state of my induction coil, I failed to get any effect. Want of time prevented me from trying again with another coil.

I told my failure to Prof. H. Haga, of Groningen University, who kindly undertook to investigate the subject. The selenium cell I made for him was of the Shelford-Bidwell type (NATURE, November 18, 1880), the working surface was 20 × 44 mm. The resistance of this cell was in darkness 31,600 ohms, in diffuse daylight it was about 15,300.

Prof. Haga with this cell got the following results, which I publish in this letter with his full approval.

The Crookes' tube he used was of the ordinary pear form (not a focus tube), and highly evacuated, giving undoubtedly a very strong Röntgen effect. The induction coil was one of Ruhmkorff's, of a length of 60 cm.; the battery for driving the coil consisted of five accumulator cells.

The distance between the selenium cell and the under part of the tube was 3 cm. The cell was covered with pasteboard, and over this was laid a thick sheet of zinc. The resistance of the cell was now measured by the bridge method, one dry cell acting as the battery, contact being of course made only momentarily. The resistance in the dark was found to be 31,600, as I remarked before. Now the induction coil was started and worked during just one minute; the resistance of the cell was then immediately measured again, and found to be exactly the same. This proved the wires carrying the induced currents and the coil itself to have no influence on the cell.

Now the zinc plate was removed and replaced by two thin aluminium sheets (two instead of one, to prevent heat rays falling on the cell). The coil was now worked during one minute, and immediately after stopping it the resistance of the cell was taken. This was now found to be 26,400.

The resistance was not measured *during* the radiation, else it would probably have been found to be a little less than 26,400, but immediately after the coil having been stopped. The measuring of the resistance took about one minute. After having left the cell at rest during 20′, the resistance had risen to 29,500 again.

Prof. Haga made several experiments, always with the same qualitative results.

A simple kind of bolometer, consisting of strips of tinfoil (11·85 Ω) did not show any change of resistance by Röntgen radiation.

It follows from these experiments of Haga's, that Röntgen rays act on the resistance of selenium in the same way as light and heat rays do. I think selenium will be found to be very useful in investigating the opacity of different substances for the Röntgen rays, and also for experimental work on the polarisation of those rays, as the deflection of a galvanometer is much easier to appreciate than the value of the photochemical action of the rays. It also follows from these experiments, that selenium is a very unfit material for making photometers.

It must always be kept in mind, when working with selenium, that the cell takes very little time in diminishing its resistance under the action of light, or other rays, but that it takes a much longer time (often half an hour or so) to return to its state of high resistance. It follows from this, that if one wishes to compare the action of two emissions, one must begin with the feebler radiation and afterwards let the stronger radiation hit the cell.

The Nature of Röntgen Rays.

The nature of Röntgen rays is so far from being settled, that the following remarks by Prof. W. N. Hartley, in favour of the ultra-violet theory, will be read with interest:—

The great doubt which prevails as to the nature of Röntgen rays arises from the fact that it is difficult to imagine radiations which make their existence manifest in a manner which, at first sight, appears very extraordinary.

Their intractability to the action of ordinary refractive media, and the facility with which they are transmitted by matter which has the property of absorbing light, has led to their being regarded as being propagated by vibrations differing in direction from those of other known forms of energy. I have given expression to the view on more than one occasion that they are simply ultra-violet radiations of much greater oscillation frequency than any we have yet been able to recognise and manipulate with prisms and lenses. The following comparison of the properties of the ultra-violet with those of the Röntgen rays are my reasons for this view:—

(1) Ultra-violet rays can be reflected and refracted.
(2) They are capable of energetic chemical action.
(3) They cause fluorescence.
(4) They facilitate the discharge of electricity through air.

(1) The Röntgen rays can be reflected, but have not hitherto been refracted.
(2) They cause energetic chemical action.
(3) They cause fluorescence and also phosphoresence.
(4) They cause the discharge of electricity through a non-conductor.

The ultra-violet rays are also subject to energetic absorption, which increases with the molecular mass of the absorbing substance in certain cases, but is dependent upon molecular structure in other instances. Röntgen rays are also absorbed energetically by some substances, and the absorption appears to be dependent upon the molecular mass of the absorbing medium, but in other cases it appears to depend upon what is probably molecular structure. Both the ultra-violet and Röntgen rays are revealed to us by their action on a photographic plate and on fluorescent substances, or rather substances which they render fluorescent.

The ultra-violet rays excite fluorescence in almost all substances, and with very remarkable effects in many cases (*J. Chem. Soc.*, vol. clxiii. p. 247, 1893). The effect of substances on the rays which enter them is to retard their rate of vibration. By retardation the length of the waves is increased to dimensions which bring them within the limits of visibility, and the result is either fluorescence or phosphorescence. This is usually expressed by saying the rays are lowered in refrangibility. It is quite probable that we may soon have evidence of refraction of Röntgen rays. They are undoubtedly reflected, since Jackson has shown that the most effective form of Crookes' tube is one in which a plate of platinum at an angle of 45° reflects the rays through the side of the vessel (*Proc. Chem. Soc.*, March 6, 1896).

Röntgen rays are in all probability of the same character as the ultra-violet rays; they produce the same effects, and no other rays are known to do this, except such as are of the same character and are capable of being "lowered in refrangibility," or retarded. But it is evident that they must be of much greater oscillation frequency, or what amounts to the same thing, of much shorter wave-length than any which have hitherto been studied with lenses and prisms of rock-crystal or fluor-spar.

Mr. Jackson has declared his adherence to the belief that they are propagated by transverse, and not by longitudinal, vibrations (*J. Chem. Soc.*, vol. clxv. p. 734, 1894; also *Proc. Chem. Soc.*, March 6, 1896).

I have been induced to place these remarks on record, because in NATURE (p. 45) there appears an abstract of a paper in *Wiedemann's Annalen*, by D. A. Goldhammer, which renders it evident that from other considerations he is of the same opinion. He points out that the peculiarities of Röntgen rays are not inconsistent with transverse vibrations of very small wave-length. His reference to the absence of reflection appears to be not strictly accurate, so far as one may judge from the words of the abstract; but it is not fair to draw conclusions from an author's views without regard to his *ipsissima verba*.

Analysis of Röntgen Rays.

Mr. T. C. Porter, of Eton College, appears to have made an interesting discovery in connection with the Röntgen rays, viz. that they are of at least two different kinds. We print in full a preliminary account of the experiments which have led to this conclusion, with the remark that the photographs received just as we go to press entirely bear out the description.

A Röntgen tube (Newton and Co.'s and Griffin's focus tubes have been used in these experiments) emits two different kinds of rays. To one kind, which I venture to call X_1, flesh is fairly transparent, and bone opaque; to the rays of which this is a preliminary account, which will be called hereafter X_2, flesh seems nearly, if not quite as opaque as bone. Under ordinary circumstances, in the cold, using an induction coil ($3\frac{1}{2}''$ spark) and somewhat rapid hammer contact breaker, most, but not all, of the rays are X_1; but if the tube be heated, less and less of X_1 are emitted and more of X_2 until the fluorescent screen (mine is one of Messrs. Reynolds and Branson's, of Leeds, bright yellowish green in colour, and apparently of uranium glass, though of this I am not sure) shows the shadow of a hand held behind it sharply defined and very dark all over, *the bones not being visible*. The back of the screen is covered with a layer of very opaque (to ordinary light) thick black paper. Up to a certain temperature the green fluorescence of the glass of the tube increases very markedly, but the X_2 rays do not come from it, as the sharpness of the shadow shows; nor are the X_2 rays ordinary kathode rays, for the same discharge sent through a highly exhausted Crookes' tube showing "independence" of the positive pole failed to excite any fluorescence whatever on the screen, though the glass of the tube was fluorescing brilliantly opposite the concave kathode, and the violet cone of rays within the tube was plainly visible. At a certain temperature, judging from the fluorescence on the *screen*, the emission of these X_2 rays reaches a maximum, and on further heating the emission of any rays whatever capable of exciting fluorescence or photographic action falls off rapidly, though, so far as my experiments have gone, *some* fluorescence and photographic action have been plain up to the highest temperature to which I judged it wise to heat the tube. Wood and paper seem very fairly transparent to the X_2 rays, but glass seems very opaque, aluminium much more opaque than to the X_1 rays, judging by the following experiment, which shows best the existence of these radiations and their difference from the X_1 radiations.

A "Röntgen" whole plate was wrapped in two thicknesses of the black paper generally used for the purpose, and supplied with the plates by the Sandell Plate Co., and brought in darkness into the room for experiment, lit dimly by a single candle at some distance from the place where the plate was to lie. The plate was then laid film uppermost (still, of course, wrapped in the black paper) six inches below the exhausted tube (the latter placed in the usual position). A piece of plate-glass, one-third of an inch thick, was then laid over half of it, and a left hand laid on the other half, together with a piece of a small aluminium tray, and exposure was made for one minute with the exhausted tube cold (16° C.). The paper over the exposed half was then marked for the purpose of recognition; this half was then covered with the glass, to protect it from any further action, and the photographic plate turned in its own plane through 180° about a vertical axis, to enable the operator to place his hand on the other half in exactly the same way as at first. The tube was then heated with a spirit-lamp giving a large flame for about forty-five seconds, and, the left hand being in position, the current was switched on for one minute; at the end of this time the appearance of the discharge in the tube showing that the latter was growing cold, the current was switched off, the spirit-lamp again applied to the tube with the right hand, the operator's left hand being kept rigidly in position over the plate, then the current put on again for a minute, and so on, the spirit-lamp and current alternately, till six and a half minutes' (the current at the last time ran a minute and a half) exposure had been given. The plate was then removed and developed uncut, with a hydroquinone developer, with the result that *whilst the far denser background of the last exposed half of the plate showed that it had received by far the greater amount of radiant energy* from the heated tube during its six and a half minutes' exposure, only the very faintest traces of the bone shadow could be made out in the very bold shadow of the flesh of the fingers; and on the other half, which had received but one minute's exposure to the cold tube, images of the bones were very clearly shown. This experiment proves that the radiation received from the hot tube resemble the rays hitherto called X rays (which I have called X_1) in being able to pass through paper opaque to ordinary light, but differ from them in being unable to pass through flesh, and in other ways, an account of which must be postponed for a short time. The effect of *cooling* the X-ray tube is being investigated.

I have spoken of these rays as a new *kind* of X rays. They may be related to the X_1 rays in the same kind of way as red is related to violet light, and if so are not essentially different. Hence I could think of no better nomenclature than to retain the letter X for them, and call them provisionally X_2; but *if they have the power of penetrating aluminium at all*, they certainly act in some respects so differently from the X_1 rays, that one might feel inclined to suspect them of some greater difference than the fluorescent and photographic experiments indicate.

Plant Structure Revealed by Röntgen Rays.

Mr. George J. Burch sends the following account of experiments from the University Extension College, Reading:—

Since February 13, I have been engaged, in conjunction with my colleague Mr. Dodgson, and Messrs. Herbert, Hooper, Soper, Twiney, West and Yetts, in a series of experiments with Röntgen rays. In investigating the influence of colour upon the relative opacity of certain substances, it occurred to Mr. West to compare a purple hyacinth with a piece of purple glass which had proved remarkably opaque. I found upon development that details of the structure of the flower were distinctly visible. Following up this clue, we have photographed a number of flowers with the Röntgen rays. By suitably arranging the exposure and the development, we can show the ovules inside the ovary in an unopened bud, the seeds within a seed vessel, and even the veins upon the white petal of a flower.

Apparently these results are due to refraction and reflection of the rays when the incidence is sufficiently oblique. Similar indications are visible in a photograph of a fish's eye prepared by Mr. Yetts, in which there is a narrow dark shadow that can only be due to internal total reflection. The feathers are seen in a bird by Mr. Soper, and a foot, developed by Mr. Herbert, shows the fabric of the stocking.

I am directing the experiments with the view of photographing the soft tissues of the human body.

A Photometer for Röntgen Rays.

All those who have had occasion to use Crookes' tubes to produce Röntgen rays will have noticed the extraordinary variations in the intensity of the radiation produced by an apparently trifling change in the vacuum and the make and break of the coil. A useful step towards some quantitative measurement of the intensity of Röntgen rays has been made by M. Meslin, who, in the current number of the *Journal de Physique*, gives an account of a photometer for the rays. The principle on which this photometer depends is the matching of the brilliancy of the two halves of a circular patch of barium-platino-cyanide, one half being rendered fluorescent by Röntgen rays, and the other rendered fluorescent by the light rays proceeding from some standard source, such as a candle or lamp. The light is passed through a coloured glass, so that the fluorescence produced has the same tint as that produced by Röntgen rays. The author finds that the barium-platino-cyanide, under the influence of Röntgen rays fluoresces with a light of such a colour that the maximum brilliancy occurs for a wave-length of about $0.500\,\mu$. The barium-platino-cyanide fluoresces most strongly when exposed to light having a wave-length of about $0.460\,\mu$. By means of this arrangement the author has been able to verify the law that the intensity varies inversely as the square of the distance, the following numbers being obtained:—

Distance of photometer.	mm.	mm.	Quotient.
From luminous source	350 ...	410 ...	0·853
From source of Röntgen rays	54 ...	63 ...	0·857

The Fluorescence of Photographic Plates.

As recently stated in NATURE (*ante* p. 62), it is well known that a photographic dry plate exhibits fluorescence when Röntgen rays fall upon it. With reference to this, Mr. Shelford Bidwell believes the seat of the fluorescence appears not to be in the sensitive film, but entirely in the glass support. Writing under date May 27, he says:—

I find that bromide, iodide and nitrate of silver do not by themselves show the slightest trace of fluorescence, neither does photographic gelatine; bromide paper and coated celluloid sheets are also quite invisible under Röntgen radiation. On the other hand almost any specimen of glass will, with a good tube, fluoresce sufficiently to show coins in a purse &c.; indeed, some of the pieces that I tried happened to be more efficient than any of the ordinary dry plates that were at hand.

No doubt certain photographic plates—possibly those used by Mr. Walker—are for special purposes prepared with fluorescent substances, and it is not surprising that such should fluoresce more strongly than others.

Miscellaneous Observations.

From the *Sitzungsberichte der Kaiserlichen Wiener Akademie* we learn that Prof. G. Jaumann has investigated the deviation of kathodic rays produced by electrostatic force. The rays follow the lines of electrostatic force, and such forces produce a strong deviation in the rays. This deviation is a temporary effect, which is soon brought to an end by the lengthening of the rays. Simultaneously with this electrostatic deviation of the kathodic rays, considerable variations take place in their intensity.

The similarity between the effects of Röntgen rays and of ultra-violet light on electrified bodies, forms the subject of a paper communicated to the Academy of Bologna by Prof. Augusto Righi, in which the author considers the influence of the pressure of the gas surrounding an electrified body on the discharge of its electrification produced by these rays. It appears that, under similar conditions, the critical pressure (that is the pressure of the gas corresponding to the maximum leakage) is greater for Röntgen rays than for ultra-violet rays. But the final charge of a conductor exposed to Röntgen radiations was found by Prof. Righi to increase with diminishing pressure of the surrounding air precisely as occurs when ultra-violet rays are brought into action instead. In another paper (*Atti R. Accad. Lincei*), the same writer dissents from Prof. J. J. Thomson's opinion that every dielectric becomes a conductor when it is traversed by Röntgen rays. Prof. Righi is of opinion that it cannot be considered as proved that a *non-gaseous* dielectric is rendered a conductor when it is traversed by these rays.

While recently experimenting with a Crookes' tube, Prof. Francis E. Nipher observed that the circular aluminium disc of the kathode became slightly loose on the aluminium wire, and that it was constantly rocking in rotary motion on the wire. After several days of use, during which it had been decided to construct a tube with discs capable of rotation, the kathode disc suddenly became loosened, and began to rotate slowly on the wire as an axis. The direction of rotation was contrary to the hands of a clock, when the disc was viewed from the point where the kathode wire pierces the wall of the tube. When the loose disc was made the anode, no tendency to rotation was observed. Up to May 4, when Prof. Nipher read a paper on the phenomena before the St. Louis Academy of Science, all attempts to produce the effect in air of ordinary pressure had failed. The experiment seemed to form a basis for imposing a term representing a rotation into the equations for force and potential within a wire conductor; but in a letter received a few days ago, Prof. Nipher suggests that a circular or elliptical vibration of the kathode wire might possibly account for the rotation of the kathode disc. The tube on which the observation was made has been cracked, and now ceases to give the result; nor is he able to impart rotation in one direction only by familiar mechanical means that could have existed in the tube.

From across the Atlantic, correspondents of some of the daily newspapers have sent vague reports of several developments of Röntgen ray work. By coating the inside of a Crookes' tube with fluorescent crystals, Mr. Edison is stated to have produced an electric lamp in which "all the energy which in an incandescent lamp is lost in heat is turned into light. One of the new lamps of only four-candle power is said to give a light equal to that obtained by the usual sixteen-candle power incandescent lamp."

A report from the electrical laboratory of the State University of Missouri states that experiment shows that Röntgen rays kill the bacilli of diphtheria. Two guinea-pigs were inoculated with a culture of diphtheria. One of them was exposed for four hours to these rays, and showed no signs of diphtheria. The other died within twenty-eight hours, and the post-mortem examination showed that diphtheria was the cause of death. It hardly needs pointing out, however, that this evidence is not sufficient to justify the conclusion.

In *Cosmos*, M. R. P. Leray gives the first portion of an article on kathodic rays and the kinetic theories of their nature. The writer points out that although recent investigations have cast some doubts on Crookes' original "radiant matter" theory, no satisfactory alternative theory has been suggested. M. Poincaré has propounded the hypothesis that the phenomenon is produced like a luminous phenomenon, but, as he remarks, this is a very strange form of light. M. Leray considers that this substitution of the ether for radiant matter, while failing to account for the earlier experimental results, affords no explanation of recent discoveries. The kinetic theory should not be abandoned, simply because it does not account for all the observed phenomena, until some theory has been suggested that better accords with fact.

Finally, in the *Naturwissenschaftliche Wochenschrift*, Prof. B. R. Borggreve offers a theory of the existence of Röntgen rays, and considers particularly the relation of Röntgen's discovery to Le Bon's so-called "dark light."

THE RELIEF OF THE EARTH'S CRUST.

PROF. HERMANN WAGNER, of Göttingen, one of the best-known geographers and statisticians of Germany, has recently published in *Gerland's Beiträge zur Geophysik*, a critical study[1] of a somewhat exceptional kind. The moral of the criticism is that the agreement of the final results of a prolonged series of calculations is no proof of the correctness of the individual stages of the work, and the application is that no elaborate series of calculations should be built upon until every step has stood the test of independent verification. One is tempted to suppose that all scientific workers believed in these principles, and that the steam-hammer strokes of Prof. Wagner's ponderous criticism are really more valuable in forging a firmer structure of fact, than for the sparks of proverbial philosophy elicited by battering the work of pioneers. The solid outcome of the investigation is the most detailed calculation yet arrived at of the area and volume of the portions of the earth's crust above and below sea-level, leading to a new and interesting division of the surface of the lithosphere into regions of special morphological character. Although this comes last in the discussion, we prefer to place it first in the appreciation, because constructive work is always more pleasing to contemplate than destructive efforts, and because those who, like myself, have been somewhat severely handled by Prof. Wagner, will probably be most willing to acknowledge the superior accuracy of his results.

The question of the completeness of the data from which these results are derived, and their fitness for such minute treatment, I shall consider later.

By means of the hypsographic curve connecting elevations and percentages of area (previously employed by Penck in his discussion of Murray's data) derived from measurements of height, depth and area of land and water, the surface of the lithosphere is divided by Wagner into five regions in place of the three suggested by Dr. John Murray, and hitherto accepted by most physical geographers. The five are as follows. The *Culminating Area* of the earth's crust, occuping 6 per cent. of the surface, and lying altogether above 1000 metres, with a mean height of 2200 metres (or 7200 feet) above the sea. The *Continental Plateau*, occupying all the surface from the 1000 metre contour-line of elevation to the 200 metre contour-line of depth, *i.e.* to the margin of the shallow sea-border or continental shelf. It comprises 28·3 per cent. of the surface, and has a mean elevation of 250 metres (or 800 feet) above the sea. The *Continental Slope*, from a depth of 200 metres to 2300 below sea-level, covers 9 per cent. of the earth's surface, and has a mean depth of 1300 metres (or 4300 feet). The *Oceanic Plateau*, between the depths of 2300 and 5000 metres, occupies no less than 53·7 per cent. of the surface, and has a mean depth of 4100 metres (or 13,500 feet). Finally the *Depressed Area*, deeper than 5000 metres, is assumed to occupy 3 per cent. of the surface, with a mean depth of 6000 metres (say 20,000 feet). In this classification of regions the coast-line is ignored, the abrupt change of slope at 200 metres (or rather the familiar 100-fathom line of our charts) being rightly given the greatest weight in a hypsographic study. The mean level of the surface of the earth's crust is placed by these calculations at a depth of 2300 metres, or 7500 feet below actual sea-level. The area of the continental-block, or region above the mean level of the crust, is found to be 43·3 per cent. of the surface, leaving 56·7 per cent. for the deeper region, instead of the 50 per cent. to which my first estimate of mean-sphere-level from Murray's data pointed. Although I suggested in April 1890, the restriction of Murray's term Abysmal Area to the ocean-floor below mean-sphere-level (instead of including everything below 1000 fathoms), and to class the whole slope up to sea-level as the Transitional Area, keeping the term Continental Area for the land; I gladly recognise the importance of Wagner's new division into five zones, as shown on the accompanying curve (p. 113). Two further subdivisions might be appropriately introduced—the *Flat lands* below 200 metres of elevation, and the *Continental Shelf*, or shallow sea above 200 metres of depth. From the anthropogeographical point of view, these are the most important regions of the globe. The height of 200 metres above actual sea-level corresponds by Wagner's showing to the mean level of the physical globe (lithosphere and hydrosphere), and is thus as fitted to be a limit as is the line of mean-sphere-level itself.

The total area of land is worked out at 28·3 per cent., and that of sea as 71·7 of the earth's surface, certain assumptions being made for the unknown polar regions. The ratio of land to water surface is thus 1 : 2·54. Other interesting levels are that of the mean height of the land 700 metres (or 2300 feet) above actual sea-level; and of the condensation spheroid, *i.e.* the physical globe if the water were condensed to the density of the rocks of the crust, 1300 metres (or 4260 feet) below present sea-level.

While Prof. Wagner has sought to give more exactness to the calculations on which our knowledge of the forms of the earth's crust depends, he has shown little sympathy with any suggestions towards an explanation of terrestrial relief. We have not space at present to consider his criticism of the remarkable relations between the various natural divisions of the crust involving the ratio of the densities and volumes of land and sea pointed out by Romieux in December 1890. Similarly the strictures on Penck's "Morphologie der Erdoberfläche" may be left for that distinguished physical geographer to treat personally.

The problem of finding the areas and volumes of the portions of the earth's crust above water or covered by water, and so of arriving at some knowledge of the true forms of the earth's crust, has been attacked by several physical geographers during the last twelve years. Prof. De Lapparent, in 1883, was the first to repeat Humboldt's attempts in this direction. Dr. John Murray, in 1888, published a very elaborate calculation based on contoured maps specially prepared by Bartholomew on Lambert's equivalent projection on the scale of 1 : 45,000,000. This work was criticised on publication by Prof. Penck and Dr. A. Supan, but attained wide acceptance. Prof. Wagner, for the purposes of his well-known statistical annual, "Die Bevölkerung der Erde," had collected the best estimates of the areas of the various continents and countries, and has caused corrections and new measurements to be made from time to time. All this work may be said to depend on the measurement of

[1] "Areal und mittlere Erhebung der Landflächen sowie der Erdkruste. Eine kritische Studie insbesondere über den Anwendungsbereich der Simpson'sche Formel" Von Hermann Wagner. *Gerland's Beiträge zur Geophysik*, II. Band, 2-4 Heft (1895), pp. 667-772.

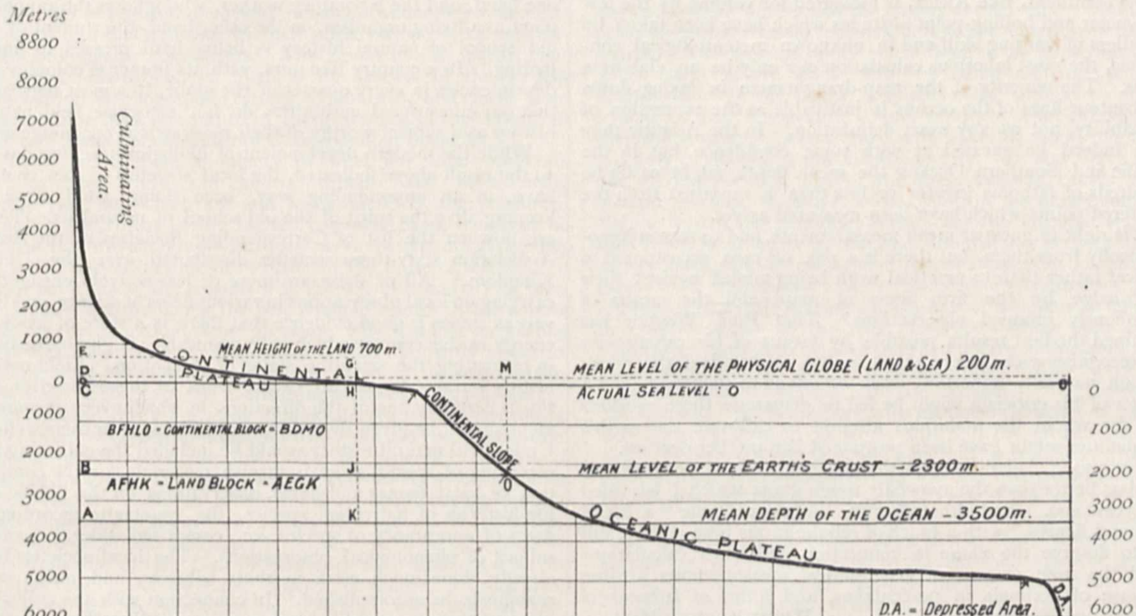
areas on maps by means of the planimeter. In 1891 Dr. Heiderich, a student of Prof. Penck's, published a series of calculations of areas and volumes of land and sea, based on an entirely different process. His method was to draw profiles of the earth's crust from contoured maps along parallels 5° apart, from the highest northern to the highest southern latitude for which data could be found. The areas of land or water for each zone of 10° of latitude wide were calculated from the length of the land or water on the three parallels 5° apart, by Simpson's formula

$$F = h/6\ (d + 4d_1 + d_2)$$

where F = the area of the zone 10° wide, h the value of the 10° interval in units of length, d, d_2 the length of the land (or of water) on the parallels bounding the zone, and d_1 the length on the parallel midway between them. Then using the *areas* of the profile above or below sea-level on each parallel, the volume of land (or of sea) in a zone of 10° is calculated by the same formula; in this case F standing for volume, and d for measured areas.

much importance. Were it not for the balancing of innumerable errors of measurement, we could not hope to gain any information at all from planimeter work on small scale maps, and no two independent measurements could possibly agree. Visible errors must of course be excluded by the exercise of all possible vigilance; but even in Prof. Wagner's critical pages there are one or two examples which show that the best intentions, the utmost vigilance, and a life-long experience of the desperate deceitfulness of proofs cannot guarantee perfect accuracy. On page 688 "II." occurs instead of "IV." in a reference to a volume, but the date being given correctly neutralises the error. On page 738 "g" should be "g_1" in referring to the mathematical formula there given, and on page 745 the expression "9,620,000 qkm. (9,000,000 + 6,200,000)" contains just such an oversight as might very seriously vitiate a calculation, the last number being obviously intended for 620,000.

The results obtained by Murray in 1888 are criticised in detail, and various sources of error pointed out. The corrections we do not hesitate to accept, but we cannot look on the original work as claiming the degree of accuracy which Wagner's criticism



WAGNER'S HYPSOGRAPHIC CURVE.

Prof. Wagner's main effort is to show the errors of Heiderich's work, first by comparison with his own new planimeter measurements, and then on theoretical grounds from the consideration of the natural difficulties introduced in Simpson's formula. In the former task Wagner was able to confirm his own estimates of the area of the land in a very neat and satisfactory way by comparison with Karsten's measurement of the oceans in zones of 10°, and he had the satisfaction of finding that the two sets of figures when added together gave a near approximation to the calculated area of the zones. The nett result of the inquiry is to show that Simpson's formula to be satisfactory must be applied to narrower zones than 10°, and that means must be taken to ensure that the intermediate values, which have four times the weight of either extreme in the final result, are really typical of the whole intermediate region. But Prof. Wagner enters into the minutest criticism of Heiderich's work, detecting errors of calculation and of typography, and showing how the use of round numbers gives rise to fresh errors in the totals. The balancing of errors which produces a fair consistency in the final result is interesting, but we believe that it receives too

implies. Had Murray's measurements been made on maps of a much larger scale, contoured at the same intervals, the results would probably have been nearer Wagner's; but we must also remember that it is the stimulus to this particular study, given by Murray's work, which has, in the ordinary course of the advancement of science, furnished his critic with data superior to those possessed in 1888.

While in several places Prof. Wagner acknowledges that his figures are only approximations, with no claims to absolute exactness on account of the uncertainty of the data, it does not appear that he realises the magnitude of this uncertainty. In the first instance measurements, even on large scale maps, are so difficult that increased precautions almost always show different results. The best example is in the case of France, where the re-measurement on the plates of the 1 : 80,000 map in 1894 showed that the area of that country was 1·48 per cent. greater than had previously been supposed. Again, it must be borne in mind that outside Europe, India, and some parts of the United States, there is not a single continental coast-line the position of which can be taken as correct. Some coast-line has to be assumed, but, except on small-scale maps, the true position is not likely to lie within the thickness of the stroke which marks it, and deviation means change of area. Finally, we have the vast uncertainty of the utterly unknown Antarctic and Arctic regions, which are estimated by Wagner to amount to 16,000,000 and 5,000,000 square kilometres respectively, or together 4 per cent. of the whole earth's surface. In the face of all this uncertainty, does it not seem that only the balancing of errors can give an approximation to the truth regarding the areas of land and water; and that from the circumstances of the case, the fact that one set of estimates disagrees with another, independently made, is of small account? While every precaution should be taken to exclude errors of computation or of typography, it may be affirmed as a principle, that to subject uncertain data to a too rigorous discussion is waste of labour. Round figures alone can be justified for many a long day in estimating the areas of the earth's surface, and for longer still in estimating the volumes of oceans and continents.

The contour-lines on any ordinary map of a continent are only the roughest generalisation of the height, even when numerous points of altitude are fixed by exact levelling. But where a whole continent, like Africa, is measured for volume by the few barometer and boiling-point altitudes which have been taken by travellers of varying skill and in unknown meteorological conditions, the most laborious calculation can only be an elaborate guess. The temerity of the map-draughtsman in laying down the contour-lines of the oceans is justifiable as the expression of probability, not as any exact delineation. In the Atlantic they may indeed be guessed at with some confidence, but in the Pacific and Southern Oceans the mean depth might easily be hundreds of fathoms greater or less than is supposed from the scattered points which have been measured as yet.

It is right to guess at mean measurements, and to reason hypothetically from them, but there is a risk of men accustomed to critical rather than to practical work being misled against their knowledge by the firm lines of maps and the means of ingeniously grouped observations. That Prof. Wagner has obtained the best results possible by means of his calculations we recognise with sincere pleasure, but he has had the good, though naturally imperfect, work of others to start from, and a reader of his criticism might be led to disparage those workers but for whom the ambitious attempt to calibrate the earth's inequalities might have been postponed for another century.

For myself I gladly accept the new value of the mean-sphere-level as better than the avowedly rough guess which I hazarded six years ago. And although Prof. Wagner calls me "a friend of round figures," with a touch of rebuke in his tone, I shall still try to deserve the name in connection with such calculations until the improvement of geographical measurements justifies the use of decimals in percentages, and fifties of fathoms in average oceanic depths.

Hugh Robert Mill.

THE WORK OF LOCAL SOCIETIES.

The practical methods of modern biological research have been developed to such a high state of perfection since the introduction of the appliances of physics and chemistry, that the system of training in biology has within a comparatively short period undergone a complete revolution. As one result of this change the student is tempted from the fields and hedgerows, from the downs, heaths and woodlands, from the banks of streams, and from the sea-shore into the laboratory. He knows the structure of a certain number of "types," but he walks as a stranger among the living animals and plants that surround him. His knowledge is not of that kind attributed to the wise king who "spake of trees, from the cedar-tree that is in Lebanon, even unto the hyssop that springeth out of the wall: he spake also of beasts and of fowls, and of creeping things, and of fishes." The organism is to the modern student not a living entity having a beautifully adjusted relationship to its environment, but a complicated collection of tissues capable by appropriate treatment of being spread out into a panorama of thin slices. His acquaintance with the living plant or animal is of about the same kind as that which a chemist ignorant of mechanics would acquire by endeavouring to understand the working of a watch by making a chemical analysis of its wheels and springs. In brief, the extreme specialisation of laboratory work begins too early in his curriculum. Since the introduction of the system of instruction by "types," there has arisen an estrangement between the old school of field naturalists and the modern biologist—a result which was not anticipated by the founders of this system, and against which a healthy reaction, led by Mr. Thiselton-Dyer and others, is beginning to take place.

It is true that certain departments of biology have gained enormously by the introduction of modern methods, and it must also be admitted that some branches, such as morphology and physiology, are best dealt with in laboratory and dissecting-room. But at the same time it is to be deplored that the department which Prof. Ray Lankester has happily termed "bionomics" should be allowed to suffer by competition with the new methods. If biology has gained in some directions, it is certainly the case that as a subject for the scientific training of the observing faculties, it has suffered deterioration by leaving the field naturalist outside the pale. The latter, finding himself threatened with scientific excommunication, is driven into the pages of popular magazines, or writes books which, although often very pleasant reading, are painfully sterile from the purely scientific point of view, and most disappointing when the capabilities of the writers are taken into consideration. Between the cabinet systematist who studies nature in museums, on the one hand, and the laboratory worker, who ignores the animal or plant as a living organism, on the other hand, the student of the old school of natural history is being hard pressed to find a footing. In a country like ours, with its immense colonies and dependencies in every quarter of the globe, it is most regretable that our educational authorities do not recognise field natural history as a subject worthy of their most serious encouragement.

While the modern development of biological teaching has led to the result above indicated, the local societies of this country have, in an unpretending way, been doing good work by keeping alive the spirit of the old school of naturalists. There are now on the list of Corresponding Societies of the British Association sixty-three societies distributed over the United Kingdom.[1] All of these are more or less actively engaged in carrying on local observations in various fields of science, and their very existence is good evidence that there is a store of available energy in this country which is by no means a negligible quantity in estimating the scientific status of the nation. Field natural history forms a large part of the work of these societies, and this is certainly one of the directions in which every encouragement should be given by all who are interested in their welfare. Under field natural history would be included the collecting and recording of species so as to furnish materials for the compilation of local faunas and floras, observations on the habits and life-histories of individual species, the systematic recording of dates of appearance of species, &c., comprised under the general subject of phenological observations. The local societies have already done much work in these subjects, and much more remains to be accomplished. In connection with the collecting of specimens it might be well to point out that these societies can do an enormous service by discouraging on every occasion the unnecessary destruction of life—by teaching by precept and showing by example that the mere acquisition of specimens is not the end and aim of natural history work, and that when a typical collection has once been formed the needs of science have been met. Most particularly is the assistance of the local societies wanted in protecting the "lower orders" of the animal kingdom and the rare species of plants from the depredations of the "dealer" or the avarice of the collector, for while our birds are now likely to flourish under a beneficent Act of Parliament, it is impossible to make a public appeal to the argument from sympathy with sentient beings in the case of the invertebrate classes of animals, or in the case of the rare plants which still linger in unfrequented districts. These are cases fo appeal to scientific reason rather than to sentiment. Is it too much to hope that the societies in each district should approach the landowners on whose estates rare species are know to occur, and invite them to co-operate in securing the protection of our choicest forms of animal and vegetable life?

In many other directions is there scope for useful scientific work on the part of local observers.[2] In geology, for instance,

[1] The total number of members registered as belonging to these societies is nearly 24,000. It is of course difficult to arrive at the actual numbers, because the same member may belong to more than one society; but after making every allowance for such repetitions, it will be seen that the volunteer army of scientific workers is much stronger than has hitherto been realised.

[2] For some valuable suggestions with respect to meteorological work, see the address to the Conference of Delegates at the last (Ipswich) meeting of the British Association, by Mr. G. J. Symons, F.R.S., Chairman of the Conference.

temporary sections are often exposed, which a resident in the district might take the opportunity of sketching or photographing and describing while the chance is open to him. Such opportunities are frequently lost owing to the temporary character of the work which has necessitated the excavation, and the absence of a qualified observer at the right time. It cannot be made too widely known to the members of local societies that every extensive artificial excavation is worth calling the attention of geologists to, and particularly when the society comprises no geological expert in its own ranks, because external aid might then be solicited before it is too late.

There are also certain special lines of geological work in which local co-operation has been found of great value, such, for instance, as the recording of the rate of erosion of sea-coasts, the distribution, mode of occurrence, mineralogical characters, &c., of erratic blocks, the height of water in wells, and so forth. These investigations have been, or still are being, carried on by British Association Committees, and are mentioned here simply as illustrations of the kind of work in which the members of local societies might take part. In anthropology and prehistoric archæology there is also abundant scope for local effort in the way of registering ancient remains, conducting systematic explorations, and assisting in their preservation by the appointment of vigilance committees. The needs in this department of science have been set forth in the reports of the British Association Ethnographic Survey Committee, and have from time to time been referred to in these columns in the reports of the conferences of delegates of Corresponding Societies.[1]

Thus, while there is plenty of work for local observers to do, and while the efforts which have been made in the past, and which are still being made by the provincial societies are worthy of the highest commendation, it cannot be denied that the energies of our local workers are not altogether as productive as they might be made for the cause of science. To point out a few of the reasons why the scientific activity of local societies is not producing the best possible results in the way of original investigation, may go some way towards suggesting remedies. In the first place, there is very frequently a want of co-operation between workers in the same or in neighbouring districts. This leads to a frittering away of energy by several people doing the same thing independently and unnecessarily. Such want of co-operation often arises from petty local jealousies which, however contemptible, may be powerful enough to cripple progress. Perhaps the best way to ensure co-operation is to bring the societies of the same or neighbouring counties into occasional intercourse by means of a system of federation. The Unions of naturalists' societies, such as those of Yorkshire, the Midlands, and the East of Scotland, have done good service in this way. As we have already announced, a Congress of Societies of the South-east of England was held at Tunbridge Wells on April 25. On a wider scale the British Association has for the last eleven years been giving facilities to the representatives of local societies all over the country for meeting and holding annual conferences under the official auspices of the Association. Not the least important feature of these conferences, which are regularly reported in these columns, is the opportunity which they give the delegates of learning directly from scientific experts the particular lines of work in which local co-operation is likely to be of real value to science. The work of some of the Association Committees has in this way received considerable local support, but on the whole the assistance given is not as great as could be wished. It may be useful to attempt an analysis of the causes why such aid has not been more freely rendered.

Any one who looks into the publications of local societies, or who is acquainted with the details of their management, must become impressed with the fact that the greater part of the work is done by amateurs. We do not use this term in a disparaging sense; on the contrary, it redounds to the credit of this country that so much work should be done by amateurs. But the workers of this class, however enthusiastic, are often devoid of scientific training, and are still more generally prevented by other occupations from carrying on continuous observations in any one subject. Hence the sporadic character of the work published, the want of co-ordination, and the difficulty of getting adequate assistance for the systematic recording of observations required by the prolonged inquiries undertaken by the British Association Committees. Another weakness which the amateur often possesses is the tendency to cope with too wide a range of subjects, and a desire to take in hand the whole circle of the sciences rather than devote himself to the drudgery of detailed observation in one limited field. Much good would result if it could be brought home to those who really desire to further the cause of science by local work, that the united efforts of a number of workers, each labouring in his own little domain, is in the long run the best of all methods for advancing knowledge by original contributions. If the amateur would curb his ambition, and take counsel with his co-workers, the volumes of some of the publications which have come under our notice would shrink in size, but the literature of science would gain considerably thereby.

The most promising remedy for these and other defects which are incidental to associations composed of more or less fluctuating elements appears to be the system of federation, if it can only be effected practically so as to over-ride the petty local narrowness which so frequently prevails. By co-operation the general level of the work done would be raised; it would be made more obvious to each worker that the cause of science is the one determining influence that should bind together the members of the society and the society to the Union. Numerous other advantages would naturally follow the adoption of such a course. Not the least important of these is the improved status which each society would gain by being affiliated with its neighbours. If the status is raised more support might be looked for from the wealthy county residents, who, although not themselves personally concerned with scientific work, might feel it a duty to encourage the county society. It may be pointed out incidentally that one of the most frequent causes of the collapse of local societies is the want of pecuniary support. This at least is the proximate cause; but the ultimate cause in such cases is as often as not the diminishing activity of the society itself, and the consequent loss of interest in its proceedings. It is confessedly difficult to keep up continuous active interest among such fleeting associations of members as compose the rank and file of the local societies. Many join at the foundation, carried in by a wave of temporary enthusiasm which soon dwindles down to an evanescent ripple, ending in the dead calm of indifference and ultimate secession. Or, again, the officials who float the society with all the enthusiasm of novelty may leave the district, or, worse still, kill the creation of their youth by the decrepitude of old age, and by tenaciously holding office convert the association into "a one man society" with a fossilised official for its executive. Truly it has been said that a local society is just what its secretary likes to make it. With federation and co-operative action there would arise a stimulating influence tending to prevent the decline of any one of the federated societies through these or any other of the thousand natural causes that affect the healthy existence of such associations. There would also be added to these beneficial effects an increased element of stability and permanence, more particularly if the societies constituting the federation were bound together by having one common publication. With respect to this last suggestion, there is everything to be said in its favour from the point of view of economy, from the point of view of avoiding the unnecessary duplication of editorial work, and, not least, from the point of view of diminishing the amount of printed matter which the scientific reader is now supposed to assimilate.

Many other aspects of the work of local societies might have been dwelt upon with advantage, but this want of centralisation appears to be one of the chief causes why their scientific productiveness is not commensurate with the number of workers scattered throughout the country. We should like to see the whole of the British Islands parcelled out into groups of counties, each group being represented by a federation of all the societies contained in the counties composing the group. Such Unions are wanted, for example, by the South Eastern, the South Western, and the Western counties, as well as by East Anglia and other naturally associated groups of counties which will suggest themselves. The formation of these Unions would not only strengthen the societies already in existence, but would lead to the establishment of other societies in districts that were not already provided for. There is no reason why, in view of all the available scientific energy which is known to exist, the local society should not become a real power in each district—a centre of intellectual enlightenment worthy of public recognition and support in the same sense that every other

[1] See an article by the writer, in NATURE, vol. xxix. p. 19 (1883).

county institution has a claim upon the county residents. The foundation and maintenance of local museums is distinctly a part of the work of the local societies; in so far as these museums can be utilised for educational purposes, they have a claim to support from the County Councils, and in a few cases such support has actually been given. We note with satisfaction that the London County Council in the estimate for the expenditure by its Technical Education Board for the ensuing year has allocated a certain sum to "museums." The county of Essex is, we believe, unique in having attached to its Technical Instruction Committee a certain number of representatives of the local society. In agricultural and maritime districts where technical instruction centres round the sciences which are more particularly cultivated by the local societies, there is no reason why there should not always be co-operation between these societies and the County Councils. If such co-operation is at present the exception rather than the rule, it is because the local societies have not made their influence as intellectual powers felt with sufficient force. Let these societies knit up their scattered units, let their amateur workers be educated up to the necessity for carrying on systematic instead of casual observations, let them court the respect to which their labours entitle them by putting forth good evidence of activity, and they may play a far greater part in the scientific development of this country than has hitherto fallen to their lot. R. MELDOLA.

CAMPHOR.

CAMPHOR is not the exclusive product of any one natural order, genus, or species; but what is more remarkable, of closely allied species of camphor-yielding genera—one species possesses the secretion, while no trace of it is found in another. Although several kinds of camphor are articles of commerce, little, if any, reaches this country, save that obtained from *Cinnamomum camphora* (*Camphora officinarum*), a member of the laurel family, and of the same genus as the tree whose bark furnishes the spice called cinnamon. Like many other natural products of which scientific research has multiplied the applications, camphor is becoming dearer and scarcer, and the question has arisen, How is the supply to be maintained equal to the demand? The bulk of the camphor imported into Europe comes from Japan and Formosa, and comparatively little from China. This is the product of *Cinnamomum camphora*, and Dr. E. Grasmann has published[1] an interesting account of this tree, both from a scientific and commercial standpoint. He has rather overweighted his article with second-hand information respecting laurels generally and those of Japan in particular, which, as might be expected, is inaccurate in some details. Disregarding these, we find much that is interesting concerning the camphor-tree itself, which is one of the noblest objects in the forests of eastern sub-tropical Asia. It attains gigantic dimensions, surpassing all other trees of the Japanese forests, at least in girth of trunk if not in total height. Dr. Grasmann gives the recorded dimensions of various notable trees, but what is more to the point, he also gives measurements made by himself. A tree in the neighbourhood of the town of Miyazaki, Oyodomura, measured in 1894, was 14·80 metres in circumference at 1·30 m. from the ground, or 4·48 m. in diameter, and it was 35 m. high. There is an illustration of this giant reproduced from a photograph. Concerning the distribution of the camphor-tree in Japan, the author states that it grows naturally in Kinshin up to about 34° lat., and scattered in favourable situations some 2° farther north, the extreme limit being 36° 24′. It is abundant in the island of Formosa, and also occurs in the Tsusima and Luchu groups. On the mainland of China, according to Dr. Grasmann, it inhabits the coast region from Cochin-China to the mouth of the Yangtzekiang, and it may be added that it is now known to extend westwards at least as far as Ichang in the central province of Hupeh. From. Dr. A. Henry's notes accompanying his specimens in the Kew Herbarium, it appears that the wood is in great request, but no camphor is extracted; and Consul Playfair reported the same from Pakhoi, Kwangtung, in 1883. Indeed the camphor industry would seem to be at present very limited in China, although the tree is common and widely spread. The little that is exported is mostly from the province of Fokien, but the amount is increasing in the same measure as the production is decreasing in Japan. In the latter country something has been done to maintain the supply, but Dr. Grasmann holds that the present rate of planting is wholly inadequate. He urges the importance of increasing the plantations to the greatest possible extent, inasmuch as every part of the tree is useful, from the roots to the young shoots and leaves. Even the fruit is employed in the preparation of tallow. In Formosa camphor distilling has been carried on in the most recklessly extravagant manner imaginable. It is suggested that Japanese rule in the island may put a stop to such disastrous waste.

With regard to the increasing price of camphor, it has been stated in various publications that this is due to its being used in the manufacture of smokeless powder. In reply to inquiries on this point, Sir Frederick Abel wrote to the Director of Kew in November last as follows:—

"Any increase of demand, involving a rise in the price of camphor, is not due to its application as a constituent of smokeless powder. That material was used in the earliest days of the manufacture of a successful smokeless powder for artillery and small arms; but its employment was soon demonstrated to be attended with serious practical disadvantages, and its application for the purpose can therefore not be said to have been other than experimental, and of no great importance, even at that time, as affecting the market value of camphor. This substance has, however, been used extensively for many years past, and no doubt in continually-increasing quantities, for the conversion of collodion cotton into the material known as celluloid, which is applied to the manufacture of imitation ivory, tortoiseshell, horn, and a great variety of purposes."

As Dr. Grasmann observes, the greatest enemy of the camphor-tree is man, and in Japan large trees are eventually killed through the felonious nocturnal grubbing of their roots. Some birds are fond of the fruit and seed, and the caterpillar of *Papilio sarpedon* feeds on the leaves; but, except to young plants, they cause comparatively little damage. Apart from the wanton destruction of trees, the probability of the supply of camphor being maintained is seriously diminished by the fact that the tree grows but slowly in its early years. At the same time it colonises freely, and is now naturalised in several countries, notably in Madagascar, where, according to Dr. Meller, in a note accompanying a specimen in the Kew Herbarium, it was abundant as long ago as 1862, and was much used for building purposes.

Next in point of importance in producing camphor is *Dryobalanops aromatica*, a tree belonging to the Dipterocarpeæ, and inhabiting Borneo and Sumatra. The formula of ordinary camphor is $C_{10}H_{16}O$; of Borneo camphor, $C_{10}H_{18}O$; and the latter can be artificially prepared from the former. Borneo camphor is deposited in clefts and hollows of the wood, and has simply to be taken out; but it is comparatively rare, and exceedingly dear, bringing eighty times more, according to Grasmann, than ordinary camphor. Nearly the whole production is imported into China, where it is esteemed beyond the ordinary camphor, and used as incense.

Blumea balsamifera (Compositæ), a shrubby plant exceedingly common in tropical Asia, yields a kind of camphor by distillation. Hainan is the principal seat of the industry, but the crude article is refined at Canton, whence there is an annual export of about 10,000 pounds. No doubt this source of camphor could be much more extensively utilised.

Members of various other natural orders, notably the Labiatæ, yield essential oils of the same composition, and having the same properties, as camphor. Menthol is an example.

W. B. H.

[1] "Der Kampferbaum. Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens in Tōkiō," vi. pp. 277–315, with illustrations. 1895.

URANIUM.

THE introduction of the electric furnace by M. H. Moissan as an instrument of research, has opened up many new fields of work; among which the preparation of those metals whose oxides had been looked upon as irreducible by carbon, is not the least interesting. Three years ago the metal uranium was obtained in this way, and in a recent number of the *Comptes rendus* (May 18), M. Moissan gives a more complete account of the preparation and properties of this metal. The metal was isolated by three methods, by the action of sodium at a red heat upon the double chloride of sodium and uranium, $UCl_4 . 2NaCl$, the electrolysis of this double salt in the fused state, and from the oxide, by reduction with carbon in the electric furnace. All three processes give good yields, the last-mentioned being the best, if care be taken not to unduly prolong the heating in contact with carbon, and to exclude air.

Metallic uranium, when pure, is perfectly white, and is not magnetic if free from iron. It is not hard enough to scratch glass, takes a good polish, and can be filed with ease; in the electric forge it is much more volatile than iron.

M. Henri Becquerel, in the same number of the *Comptes rendus*, gives an account of a remarkable property of this metal, which appears to be unique, that of emitting invisible phosphorescent rays capable of producing photographic effects after traversing opaque bodies such as cardboard, aluminium, copper, and platinum, and also able to discharge a gold-leaf electroscope. The effects produced are precisely similar to those previously obtained from uranium salts, such as potassium uranyl sulphate, except that they are nearly four times as intense. The chemical behaviour of uranium depends to a certain extent upon its state of division. The metal obtained by electrolysis, which is finely divided, takes fire in fluorine, is attacked by chlorine at 180°, by bromine at 210°, and by iodine at 260°, the reactions in all cases being complete. The powdered metal is completely burned in pure oxygen at 170°, and decomposes water, slowly at the ordinary temperature but more quickly at 100°. Uranium must be added to the rapidly increasing group of metals which combine directly with nitrogen at high temperatures. Fragments of the metal heated to about 1000° in a current of nitrogen become covered with a yellow layer of nitride, and hence in the preparation of the metal it is necessary to work in such a manner as to completely exclude air.

SCIENCE IN THE MAGAZINES.

THE celebration of the Kelvin jubilee at Glasgow on June 15–17, makes the appearance of an article on the renowned investigator, in the June number of *Good Words*, very opportune. The author is the editor, Dr. Donald Macleod, once a student of Lord Kelvin's, and his description of the master is a most appreciative one. Illustrations of Glasgow University, Lord Kelvin's class-room, laboratory, and study, and of Lord and Lady Kelvin, give additional interest to the article.

An excellent illustrated article on "The Rise of the Royal Society," is contributed to the *Leisure Hour* by Mr. Herbert Rix, the late Assistant Secretary of the Society. Other articles of scientific interest in the same magazine are "Notes on the Zoo," by Mr. W. J. Gordon, with illustrations from photographs by Mr. Gambier Bolton; "The New South Africa," by Mr. Basil Worsfold; and "Modern Hygiene in Practice," by Dr. A. T. Schofield.

Science Gossip contains the first of a series of articles upon the scientific worthies at the National Portrait Gallery, illustrated with sketches of the pictures by Miss J. Hensman. We understand from the article that there are about thirty portraits of scientific men out of upwards of a thousand pictures in the Gallery.

An article on Africa since 1888, with special reference to South Africa and Abyssinia, by the Hon. Gardiner G. Hubbard, and accompanied by a striking portrait of the author, appears in the *National Geographic Magazine* (May). Another paper on Africa, "Impressions of South Africa," is contributed to the *Century Magazine* by Mr. James Bryce, M.P. In the *Contemporary*, there is an article by Dr. George Harley, F.R.S., on "Champagne," having medical as well as gustatory points of interest. *Good Words* has an article on "Aluminium," by Prof. Jamieson, and on "Flowers of the Forest," by Mr. Edward Step. Mr. W. H. Hudson has an article on "Ravens in Somersetshire" in *Longman's Magazine*. Among the popular articles in *Chambers's Journal* is one on "Photography in Colours," descriptive of Mr. Ives' process, and another on the Harvey process for hardening steel. Sir Robert Ball describes the planet Saturn in the *Strand Magazine*. Students of animal life may be interested in the second paper on "The Evolution of the Trotting Horse," contributed by Mr. H. Busbey to *Scribner*.

In addition to the periodicals mentioned, we have received the *Humanitarian*, *Fortnightly*, and the *Sunday Magazine*, but no articles in them call for notice here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. H. J. HEINTZ has given 10,000 dols. to the Kansas City University, the corner-stone of which has just been laid.

THE Technical Instruction Committee of the Middlesex County Council have decided to offer a scholarship, worth £50 per year for two years, tenable at the City and Guilds of London Institute. This scholarship is to be competed for by boys to whom scholarships at secondary schools were awarded in 1893. It is to include school fees, railway fares, and maintenance.

THE following are among recent announcements:—Dr. Otto Fischer to be Extraordinary Professor of Mathematics in Leipzig University; Prof. L. M. Underwood to be called to the chair of Botany in Columbia University; Dr. George A. Dorsey to be Curator in the Department of Anthropology in the Field Columbian Museum at Chicago; Dr. Franz Boas to be Lecturer on Physical Anthropology in Columbia University; Prof. Harold B. Smith to be Professor of Electrical Engineering in the Worcester Polytechnic Institute.

FOR news of the following gifts to education and research in America, we are indebted to *Science*:—Mr. Thomas McKean has offered to give 100,000 dols. to the University of Pennsylvania upon condition that 1,000,000 dols. be collected. Mr. McKean, who is a trustee and an alumnus of the University, gave 50,000 dols. about a year ago.—Mr. Charles M. Dalton has given the Massachusetts Institute of Technology 5000 dols. for a scholarship in chemistry for graduate students. Preference will be given to those undertaking chemical research applicable to textile fabrics.—Real estate and securities valued at 215,000 dols. have been presented to the North-western University by William Deering, of Evanston, who had previously given the University about 200,000 dols.

WE have to record another attempt to divert part of the funds available under the Local Taxation (Customs and Excise) Act, 1890, to the General County Fund. This time it is the Isle of Ely County Council. At their meeting held at March, on May 20, it was proposed "that £1000 of the Imperial grant be allocated to the General County Fund, instead of the £150 recommended by the Committee." The proposal was eventually rejected, it is true, but only by a majority of two in a meeting of forty. The argument which was used in the North Riding County Council a short time ago, and to which we called attention, was again repeated—that it was never the intention of Parliament for the whole of these funds to be devoted to the purposes of technical education. No stronger reason than such occurrences as these could be found for the necessity of the provision in the Education Bill that these funds must be devoted to educational purposes.

WE are glad to learn from *Science* that an effort is now under way in connection with the National Educational Association to bring about greater interest in the *teaching* of science than has hitherto been shown by American botanists, zoologists, chemists, physicists, &c. The new Department of Natural Science Instruction is intended to bring together the teachers of the natural sciences who are interested in science *as a means of culture*, and to stimulate thought and discussion as to how this end may best be obtained. What *rôle* should botany, zoology, chemistry, physics, &c., play in the mental development of man? In what way may the study of plants, animals, chemical compounds and physical forces be made an efficient factor in a man's mental training? When and how shall such study be made a part of a man's training? These are some of the questions which will be discussed in the Department of Natural Science Instruction in the Buffalo meeting of the National Educational Association, on Thursday and Friday afternoons (July 9 and 10).

THE Technical Instruction Committees of the Oxfordshire County Council have decided to devote £560 to scholarships during the next year. Of this amount £294 will be absorbed on account of the scholars already elected. The balance is to be devoted to further developing the scholarship scheme. Amongst other arrangements, we notice that it is proposed to elect three sons of tenant farmers to County Council scholarships of an annual value of £15. The candidates must have been under fourteen years of age on December 31, 1895, and must have lived in the county for two years previously. The scholarships will be held at Burford Grammar School for the first two years. Sums of £366 and £314 have been respectively allotted for capitation grants and rural agricultural instruction. The programme for the year also makes the following provisions :—For dairy instruction, £250; for manual instruction in woodwork, £228; for nursing, ambulance, and general hygiene, £190; for dressmaking, £100; for instruction in poultry-keeping, £35; for hedging and thatching, £25. We are very sceptical as to the wisdom of so diffuse a syllabus of work, and would again point out that no efforts should be spared to coordinate and systematise all the educational projects of a County Committee.

A PROSPECTUS referring to the Faculty of Applied Science of McGill University, Montreal, announces that, through the munificence of Mr. W. C. McDonald, a Department of Architecture has been established in the Faculty, and the regular work of the new department will commence with session 1896–97. During the summer, a Professor of Architecture is to be appointed, and the efficiency of the Drawing Department is to be much increased by the addition of a lecturer in freehand drawing and descriptive geometry. The same benefactor has also rendered it possible for the University to place the Departments of Chemistry and Mining in a thoroughly efficient condition. The erection of a large building is to be proceeded with immediately, and the building will be equipped in the most approved manner, including not only provision for the several branches of chemistry, but also for mineralogy, mining, and metallurgy. The Mining and Metallurgical Laboratories alone will have a floor space of about 10,000 square feet, and will be supplied with the most recent appliances for the milling and metallurgical treatment of ores, &c. A Professor of Mining will be appointed during the summer, and other important changes in the staff, all leading to increased efficiency, are to be made.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, May.—The worst gale of the nineteenth century in the English midlands. This storm occurred on March 24, 1895, and has not been fully discussed, although some local scientific societies have published short papers upon it. The present number contains part of the list of damage done in various countries; in the next number it is proposed to complete it, and to offer some general remarks upon the subject. Mr. Symons considers that the damage done is without parallel since "the great storm" of 1703. It is a curious coincidence that it occurred on the same day of the year, and nearly at the same hour, as that of the *Eurydice* squall in 1878, in which, it will be remembered, Her Majesty's ship was lost. This latter storm was discussed by the late Mr. W. C. Ley.—Fog, mist, and haze, by "F. R. Met. Soc." In the hope of initiating a discussion upon the existing absence of unanimity as to the meaning attached to the different words in general use, the author has suggested certain definitions, which are briefly as follows :—Fog; an obscuration due to condensation of aqueous vapour when the particles are too small to be seen with the naked eye. Mist; when the particles are large enough to be seen with the naked eye. Smoke-fog; obscuration without water particles. Haze; an obscuration of distant objects, so slight that the cause is not visible to the observer.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 7.—Mr. A. G. V. Harcourt, President, in the chair.—The following papers were read :—Carbon dioxide, its volumetric determination, by W. H. Symonds and F. R. Stephens. The authors describe a trustworthy method of estimating carbon dioxide in air.—On certain views concerning the condition of the dissolved substance in solutions of sodium sulphate, by R. F. D'Arcy. Experiments on the viscosity of strong solutions of sodium sulphate confirm the generally accepted view that the condition of sodium sulphate in aqueous solution is always the same, whether the solutions are prepared from the anhydrous salt or one of its two hydrates.—Luteolin, II., by A. G. Perkin. The results of the further examination of luteolin are given; it is isomeric with fisetin, and probably has the constitution

$$\begin{array}{l} C(OH).CH{:}C.CO\text{---}C.C_6H_3(OH)^2 \\ \| \qquad\qquad\quad | \qquad\quad \| \\ CH.C(OH){:}C.C(CO).CH \end{array}$$

.—Morin, Part I., by H. Bablich and A. G. Perkin. Morin, a yellow colouring matter occurring in old fustic and in Jackwood, is isomeric with, and has a very similar constitution to quercitin.—Synthesis of pentacarbon rings. Part I. Anhydracetonebenzil and its homologues, by F. R. Japp and G. D. Lander. Anhydracetone benzil has been fully investigated, and is shown to be a diphenylhydroxycyclopentane of the constitution

$$\begin{array}{l} CPh\text{===}CH \\ | \qquad\qquad\quad \rangle CO. \\ CPh(OH).CH_2 \end{array}$$

—Synthesis of pentacarbon rings. Part II. Condensation of benzil with acetonedicarboxylic acid, by F. R. Japp and G. D. Lander. The behaviour towards reagents of anhydracetonebenzilcarboxylic acid, which is obtained by the condensation of benzil with acetonedicarboxylic acid, is described.—Reduction of desyleneacetic acid, and the constitution of Zinin's pyroamaric acid, by F. R. Japp and G. D. Lander. Desyleneacetic acid yields Meyer and Oelker's desylacetic acid on reduction and $\beta\gamma$-diphenylbutyric acid on boiling with hydriodic acid and phosphorus; this acid is identical with Zinin's pyroamaric acid.—Electrolysis of potassium allo-ethylic camphorate, by J. Walker and J. Henderson.—Flourene and acenapthene, by W. R. Hodgkinson. The red substance obtained by the oxidation of flourene and acenaphthene is not a hydrocarbon, but contains oxygen; no coloured hydrocarbon can be prepared by oxidising these substances.

Mathematical Society, May 14.—Major MacMahon, R.A., F.R.S., President, in the chair.—Mr. H. F. Baker spoke upon the bitangents of a plane quartic curve and the straight lines of a cubic surface.—A paper by Prof. E. W. Brown, on the application of the principal function to the solution of Delaunay's canonical system of equations, was taken as read.—Short communications were made by the President, Colonel Cunningham, Prof. Hill, F.R.S., Mr. Hammond, and Mr. Tucker.

CAMBRIDGE.

Philosophical Society, May 11.—Prof. J. J. Thomson, President, in the chair.—Note on the formation of the layers in Amphioxus, by Mr. E. W. MacBride.—Note on the continuity of the mesenchyme cells in Echinoderms, by Mr. E. W. MacBride.—Mr. F. C. Shrubsall read a paper on crania from Teneriffe, embodying the measurements of sixty-one skulls and two hundred long bones. The average height of the islanders, calculated from the latter, was for males 1642 mm. and for females 1552 mm.

EDINBURGH.

Royal Society, May 18.—Prof. Chrystal in the chair.—Mr. W. G. Robson, St. Andrews, exhibited some X-ray photographs, and described the progress of the study at St. Andrews University. Some of the exposures were long compared with what has been done recently, notably by Dr. Macintyre; but the photographs were all very good, and the definitions remarkably clear. Some of the pictures shown were very interesting. A photo of a mummy's foot was exhibited, and Mr. Robson remarked that the rays must have had some effect on the skin, for, at the end of the experiment, it was found to be quite soft. A photograph of what looked at first sight like some insect, but turned out to be a St. Andrews "bulger" with the lead showing very clearly, caused some amusement. Prof. Chrystal thought that uranium would be of great use in intensifying X-ray photographs.—Prof. D'Arcy Thompson made a short preliminary communication on the bird and beast names in Albertus Magnus. There were very many barbarous-looking names for beasts and birds in Albertus Magnus, which have a certain resemblance to words in Aristotle. The Dominican friar did not know Greek, but used an Arabic translation of Aristotle. If the Greek words were transliterated into Arabic, they were found to be parallel with the words used by Albertus when treated in the same way.—Prof. Thompson also read a paper on the Σ of Diophantus. Diophantus used Σ for an unknown quantity. Most commentators take this to be the *s* of ἀριθμός ("ὁ ἀόριστος ἀριθμός"), but there are difficulties attached to this interpretation. Sometimes the Σ has the sign of the genitive or plural written in small letters beside it, pointing rather to the fact of its being an initial letter. Prof. Thompson suggested σωρός, a heap, connected with the heap-calculus of the Egyptians, and gave various reasons for his suggestion. If true, this hypothesis, in linking Diophantus on to the Eastern culture, deprived him of his position as the father of mathematics, and helped to prove that many of his problems, as was conjectured long ago by Morgan and Bonnycastle, were not original but were collected from

Egyptian mathematicians.—Prof. Thompson next communicated a paper by a pupil, W. T. Calman, on the affinities of the genus *Anaspides* to certain fossil Crustacea. Mr. Calman's re-examination of this remarkable fresh water schizopod from Tasmania has resulted in the discovery of certain important features not observed by its discoverer, notably the presence of what appears to be a group of ocelli on the dorsal surface of the cephalic region. The significance of this, and other morphological peculiarities, was discussed at length, and the indications of divergent affinities with Decapods, Edriophthalmates, and other groups were pointed out. Finally, it was shown that *Anaspides*, while not closely comparable with any living crustacean, possesses strong resemblances to certain Palæozoic crustacea forming the groups *Syncacida* and *Gampsonychidæ* of Packard, whose systematic position has hitherto been a complete puzzle to palæontologists.—Prof. Tait indicated the nature of his paper on the linear and vector function, and promised to give it in detail at an early date.

DUBLIN.

Royal Dublin Society, April 22.—Prof. Grenville A. J. Cole in the chair.—Mr. J. R. Kilroe read a paper on the distribution of drift in Ireland, in its relation to agriculture. The relation between the drift and the underlying rocks was discussed, and the general mode of origin and succession of the glacial deposits in Ireland were described. The importance of considering the stones included in sands or clays as sources of fertilising materials was especially dwelt on, and illustrations were given of the physical and chemical constitution of numerous Irish drift deposits. A broad system of separation of the constituents was adopted, such as would be suited to agricultural requirements.—The following abstract of a paper by Prof. T. Rupert Jones, F.R.S., and Mr. J. W. Kirkby (communicated by Prof. Sollas, F.R.S.), on the Ostracoda of the Carboniferous Formations of Ireland, was read March 18, but was not in time for publication in the report of that meeting sent to NATURE. In 1866 Messrs. Jones and Kirkby made a critical examination of all that had been published about the Carboniferous Entomostraca (Ostracoda) of Ireland, in the *Annals and Magazine of Natural History*, ser. 3, vol. xviii., pages 37–51. Having in the interval from 1866 received numerous species of Ostracoda (Podocopa) from the Carboniferous Formations of Ireland, the authors have put them, together with those already tabulated and described, in a convenient arrangement, so that geologists, and naturalists in general, should be able to form their judgment on this branch of the Palæontology of Ireland. Many of the specimens have been treated more or less fully in some of the authors' memoirs scattered in various publications (such as *Annals Mag. N. H.*, *Quart. Journ. Geol. Soc.*, *Geological Magazine*, *Proc. Geol. Assoc.*, *&c.*). Several, however, have not hitherto been adequately illustrated; and, lastly, some are new. Of the species and notable varieties, there are belonging to *Cytherella*, 7; to *Leperditia*, 10; *Beyrichia*, 3; *Beyrichiopsis*, 2; *Kirkbya*, 5; *Ulrichia*, 1; *Bythocypris*, 2; *Macrocypris*, 1; *Argillæciæ*, 1; *Krithe*, 2; *Bairdia*, 8; altogether 42. It is proposed to give a descriptive and bibliographic account of each form, with its range and localities, accompanied by good illustrations. The specimens treated of have come from Donegal, Londonderry, Tyrone, Down, Sligo, Longford, Mayo, and Cork.

PARIS.

Academy of Sciences, May 26.—M. A. Cornu in the chair.—On researches made at the observatory of Madison by G. Comstock, concerning aberration and refraction, by M. Lœwy. The constant of aberration given by these researches is 20"·44.—On the part played by the ring of iron in dynamo-electric machines; reply to the note of M. Potier, by M. Marcel Deprez.—Source and nature of the potential directly utilised in muscular work, from the point of view of the respiratory changes in man after fasting, by M. A. Chauveau. The ratio of carbon dioxide to oxygen, or respiratory quotient, mounts rapidly when muscular work is commenced, falling away, however, if the work is very prolonged. After a rest of one hour the quotient falls to the normal. Fat does not appear to be utilised directly by the muscles, even when the work is done fasting.—The immediate destination of fatty food, by MM. A. Chauveau, Tissot and de Varigny.—On the theory of gases, a letter from M. Boltzmann to M. Bertrand. M. Boltzmann points out that Maxwell himself stated the doubtful nature of his first demonstration. That this one demonstration is false, however, by no means implies that the theorem itself is false, and reference is made to independent proofs by Boltzmann, Lorentz, Kirchhoff, and others.—Reply to the preceding by M. Bertrand. Leaving Maxwell's first demonstration on one side, his second is equally indefensible. While reserving for the present a critical examination of the various proofs advanced, M. Bertrand thinks that, *à priori*, these proofs cannot be real, since all formulæ solving the problems proposed by Maxwell must contain one arbitrary function.—On the vapour pressures of some formic acid solutions, by M. I. M. Raoult. The observations were made by the dynamical method, and give a mean value of 0·713 for the molecular diminution of vapour pressure for formic acid used as a solvent. The ratio of the actual to the theoretical vapour density as found from this number is 1·55, the number obtained by Bineau by direct observation being 1·34.—Description of a mechanical flying machine, by M. Langley (see p. 80).—Letter from M. Graham Bell to M. Langley, on the same subject (see p. 80).—Observations of the sun, made at the observatory of Lyons with the Brunner equatorial during the first quarter of 1896, by M. J. Guillaume.—On the ordinary differential equation of the first order, by M. A. Korkine.—On the conditions of equilibrium of a certain class of systems capable of deformation, by M. B. Mayor.—On a new mode of regulating motors, by M. L. Lecornu.—Remarks on the preceding note, by M. H. Léauté.—On the magnetic torsion of soft iron wire, by M. G. Moreau. An experimental study of the action of a solenoid carrying a current upon a wire under torsion. The increase of torsion observed, called the magnetic torsion, is proportional to the square of the magnetising current, is independent of the diameter of the wire if the latter is small, and is always in the same sense as the original torsion.—Reply to a claim for priority of M. G. Friedel, by M. R. Dongier. The principle utilised was originally due to Fizeau and Foucault.—On the determination of the deviation of the Röntgen rays by a prism, by MM. Hurion and Izarn. The results obtained with an aluminium prism were entirely negative.—On the refraction of the X-rays, by M. Gouy. Using as the source of Röntgen rays the edge of the platinum disc in a Crookes' tube of the "focus" pattern, so that the origin of the rays is practically rectilinear, with prisms of aluminium and of crown-glass, the conclusion is drawn that the index of refraction of the Röntgen rays cannot differ from unity by more than $\frac{1}{200000}$.—Photometry of phosphorescent sulphide of zinc excited by the kathode rays in a Crookes' tube, by MM. C. Henry and G. Seguy. At a fixed pressure the brightness of the zinc sulphide falls off as the experiment is prolonged. There is a certain pressure at which the maximum intensity of light is obtained; a reversal of the current reduces the brightness to about $\frac{1}{17}$ of its original value.—Action of gaseous hydrogen iodide and phosphonium iodide upon thiophosphoryl chloride, by M. A. Besson. The reaction is analogous to that already described for phosphoryl chloride, the products being phosphorus tri-iodide, iodine, hydrogen sulphide, and hydrogen chloride.—On the hydration of pinacoline, by M. Maurice Delacre.—On a new mode of preparation of glyceric acid, by M. P. Cazeneuve. Glycerine is readily oxidised to glyceric acid by silver chloride in alkaline solution. The acid is extracted by dry acetone, in which glycerine is insoluble.—Action of ethyloxalyl chloride upon aromatic hydrocarbons in presence of aluminium chloride, by M. L. Bouveault. Reaction readily occurs with benzene, toluene, and metaxylene, more difficultly with cymene, with production of the corresponding substituted glyoxylic ethers. With cymene, a new ethyl cymene is obtained as a bye-product.—New derivatives of the cyanoacetic ethers, by M. Guinchant.—Physiological study of the Cyclamens of Persia, by MM. A. Hébert and G. Truffant. The methods of high culture usually followed for these ornamental plants do not necessarily give the largest flowers, a rich soil giving large leaves and small flowers, a poor soil the reverse.—On a new soluble oxidising ferment of vegetable origin, by M. G. Bertrand. The browning of the cut surfaces of certain vegetables, dahlia, apple, and others, is due to the oxidation of the tyrosine under the influence of a soluble ferment, an oxydase. It can be isolated from the roots of the dahlia.—On the buccal and œsophageal pouches of the *Prosobranchia*, by M. A. Amaudrut.—General observations on the distribution of the Algæ in the Bay of Biscay, by M. C.

Sauvageau.—On some Devonian bacteria, by M. B. Renault. Two species of micrococcus are described, found on fossil vegetation of the Devonian age. These are the earliest known bacteria.—On the photography of the retina, by M. Th. Guilloz. —Influence of the liver on the anti-coagulating action of peptone, by MM. E. Gley and V. Pachon.

BERLIN.

Meteorological Society, May 5.—Prof. Börnstein, President, in the chair.—Dr. Carl Müller spoke on the adaptation of plants to climate and weather, and discussed the mechanisms by which they take up water and carbon dioxide from the air, as also the various configurations of the earth's surface which either assist, limit or regulate transpiration in dependence upon climate and weather. He further gave a sketch of the means by which radiation is limited during the night, and by which the access of light to the assimilative chlorophyll corpuscles is facilitated and regulated, as also of the multitudinous arrangements for the avoidance of the deleterious action of heavy rain and violent winds.

Physiological Society, May 8.—Prof. du Bois Reymond, President, in the chair.—Dr. Cohnstein discussed certain recent papers dealing with the theory of lymph formation which oppose Heidenhain's view that it is the result of a secretory process, and tend to prove that diffusion and osmosis suffice entirely to explain the passage of the constituents of lymph through the walls of the capillaries.—Prof. I. Munk spoke on muscular work and proteid metabolism, and combated Chauveau's most recent views that the necessary energy is supplied by the oxidation of carbohydrate rather than of proteid material.

Physical Society, May 15.—Prof. du Bois Reymond, President, in the chair.—Prof. Warburg spoke on the action of light on sparking discharge, and demonstrated Hertz's earliest experiments on the influence of ultra-violet rays on the striking distance of the sparks, and on the discharge of negatively electrified bodies. He next showed Hallwach's experiments dealing with spark discharge in light, and finally his own, by which he proved that the action of ultra-violet rays consists in doing away with the retardation which, according to Jaumann's researches, exists at each discharge. This retardation, which is a forerunner of the discharge, and during which some as yet unknown events take place in the path of the spark, is lessened or even completely done away with by the action of light. He conjectured that gases, unlike electrolytes and metals whose conductivity is independent of strength of current, only become conductors when the current has reached a certain intensity. Hence possibly during the retardation the gas is becoming a conductor, and if so the action of light consists in the removal of some obstruction to the establishment of conduction.—Prof. Paalzow gave an obituary notice of the recently deceased member of the Society, Dr. Haensch.

PHILADELPHIA.

Academy of Natural Sciences, May 5.—Dr. F. P. Henry made a communication on *Filaria sanguinis hominis nocturna*, specimens of which had been obtained from the blood of a patient suffering from chyluria due to clogging of the lymphatics by the ova of the parasite. The various forms of the worm, with their life-history, as given by Dr. Patrick Manson, were dwelt on.

May 12.—Dr. Charles S. Dolley described a centrifugal apparatus, which he called a Planktonokrit, for the quantitative determination of the food supply of oysters and other aquatic animals. By means of its use he is enabled to make a large number of plankton estimates in a day, and thus judge of the characters of given areas of water in connection with fish and oyster culture at different times of the day, states of the tide, varying depths, &c. The method employed is that of the centrifuge, an apparatus which consists of a series of geared wheels driven by hand or belt, and so arranged as to cause an upright shaft to revolve up to a speed of 8000 revolutions per minute, corresponding to fifty revolutions per minute of the crank or pulley-wheel. To this upright shaft is fastened an attachment by means of which two funnel-shaped receptacles of one litre capacity each may be secured and made to revolve with the shaft. The main portion of each of these receptacles is constructed of spun copper, tinned. When caused to revolve for one or two minutes the entire contents of suspended matter in the contained water is thrown to the bottom of tubes properly placed, from which the amount may be read off by means of a graduated scale.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Cosmic Ethics; or, the Mathematical Theory of Evolution: W. C. Thomas (Smith, Elder).—Modern Optical Instruments: H. Orford (Whittaker).—Engineer Draughtsmen's Work (Whittaker).—Azimuth Tables for the Higher Declinations: H. B. Goodwin (Longmans).—Latitude and Longitude: W. J. Millar (Griffin).—Sporozoenkunde: Dr. von Wasielewski (Jena, Fischer).—Elementarcurs der Zootomie in Fünfzehn Vorlesungen: Drs. B. Hatschek and C. J. Cori (Jena, Fischer).—Apollonius of Perga, Treatise on Conic Sections: edited in Modern Notation by T. L. Heath (Cambridge University Press).—An Introductory Treatise on the Lunar Theory: Prof. E. W. Brown (Cambridge University Press).

PAMPHLET.—Staten Island Names: W. T. Davis (New Brighton, New York).

SERIALS.—L'Anthropologie, tome 7, No. 2 (Paris, Masson).—Botanische Jahrbücher, &c., Einundzwanzigster Band, v. Heft (Leipzig, Engelmann).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften Math. Naturw. Classe, 1895, i. and ii. (Prag).—Century Illustrated Magazine, June (Macmillan).—History of Mankind: F. Ratzel, translated, Part 9 (Macmillan).—Bulletin from the Laboratories of Natural History of the State University of Iowa, Vol. 3, No. 4 (Iowa).—Brain, Part 73 (Macmillan).—Humanitarian, June (Hutchinson).—National Review, June (Arnold).—Contemporary Review, June (Isbister).—Scribner's Magazine, June (Low).—Journal of the Anthropological Institute, May (K. Paul).—Bachelor of Arts, May (New York).—Zeitschrift für Physikalische Chemie, xx. Band, 1 Heft (Leipzig, Engelmann).

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