Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Nature June 27th 1889

Dmitri Ivanowitsh Mendeleeff

Engraved by G. J. Stodart from a Photograph by Warwick Brookes

London. Macmillan & Co.

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XL

MAY 1889 to OCTOBER 1889

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London and New York
MACMILLAN AND CO.
1889

RICHARD CLAY AND SONS, LIMITED,
LONDON AND BUNGAY.

INDEX

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 2, 1889.

THE NEW CODE AND SCIENCE TEACHING.

THE new Code of the Education Department[1] is now lying on the table of the House of Commons, and never, since the famous proposals of Mr. Mundella, has there been so much stir among those interested in primary instruction as at the present moment. The reason is not far to seek. For some years a Royal Commission has been sitting and taking evidence, and it has produced several bulky Blue-books during the course of the past year. It was known that the Commission was divided into a majority and minority who were strongly opposed to one another on certain questions of policy. This has found expression in lengthy reports and contradictory recommendations; but, to the satisfaction, if not to the surprise, of educationists it is found that on purely educational matters there is an almost perfect unanimity between the two sections. It was therefore a matter of deep interest to see how, and to what extent, these recommendations, signed by every member of the Commission, would be embodied in the proposed Code of 1889.

At the outset it may be well to remark that there are several alterations in this Code which are almost universally allowed to be improvements. But it is conceived in a spirit of compromise, and perhaps no party is entirely satisfied with it. The only point we have to consider is the aspect of the Code towards the teaching of natural science.

It may be convenient to group our observations under different headings.

I. The direct changes proposed in the teaching of science. These are almost confined to one or two modifications in the geographical schedule, and to a provision that "Scholars of any public elementary school may attend science classes held at any place approved by the inspectors." This may be very useful in towns, especially as it will admit of the formation of central laboratories or work-rooms similar to the present cookery centres.

II. The proposed changes which will tend to facilitate the teaching of science. There are four subjects of instruction which are termed "class-subjects": English (including grammar, composition, and repetition of poetry), Geography, Elementary Science (a progressive course of object-lessons), and History; together with Needle-work for girls. Only two of these class-subjects can be taken for examination, and, under the old Code, "English" must necessarily be one of those chosen. The consequence of this is, that "Elementary Science" has never got a footing in our schools, for even where two class-subjects are taken, they are nearly always English and Geography, or English and Needle-work. The supremacy of English is now to be put an end to, so that any teacher may now take Elementary Science, if he or she should prefer it, and earn a grant.

The enormous waste of time and patience in making little children, even in our infant-schools, learn the spelling of common words, is to be reduced. The inspector is to give no dictation exercises to boys and girls under the second standard. This will give more time for object-lessons and other valuable modes of instruction.

Some relaxation of the literary requirements are also made in the case of evening schools.

The present system of payment by results is to be so modified that the cramming in the three R.'s will not be so profitable, and there will be more chance for intelligent teaching. One of the matters also to be taken into account by the inspector in assessing a school, is the provision of "apparatus," though this need not necessarily have anything to do with what scientific men would call by that name.

These proposed changes are in the right direction, but the value of many of them will largely depend upon how they are understood. There is a singular want of clearness in some of the clauses. The annual "Instructions to inspectors" have not been yet drawn up, and indeed it is very improbable that they will make their appearance until after the Code has become law. It is quite possible to take away with one hand what is given with the other. The present agitation is therefore of great importance

[1] "Code of Regulations, with Schedules, by the Right Honourable the Lords of the Committee of the Privy Council on Education." (Eyre and Spottiswoode)

not merely in getting modifications of the Code when discussed in Parliament, but in inducing the Education Department to give their inspectors such instructions as shall secure that the greater liberty of teaching should be a reality; that the ominous word "repetition," introduced into one or two paragraphs may not become "English" in disguise; and that the spelling of the second standard should not involve a laborious preparation of the younger children.

III. These alterations bearing on the teaching of science fall far short of what the Royal Commissioners unanimously recommend. The report of the majority states that "some elementary instruction in science is only second in importance to the three elementary subjects:"—namely, reading, writing, and arithmetic, and it places among subjects regarded as essential, "geography (especially of the British Empire); lessons on common objects in the lower standards leading up to a knowledge of elementary science in the higher standards." It adds, "That geography, if properly taught, is a branch of elementary science, which should not be separated from the other branches, and might well be taught along with object lessons, in accordance with the recommendations of the Royal Commission on Technical Instruction"; "that the curriculum in the ordinary elementary schools might often include not only instruction in the elementary principles of science, but also, in certain standards, elementary manual instruction in the use of tools, and in higher schools and evening schools this work might be carried still further"; "that, in making future appointments to the office of inspector, it would be desirable, in regard to a larger proportion of them than at present, to give special weight to the possession of an adequate knowledge of natural science." The members of the minority express themselves, if possible, more strongly; and make such additional remarks as, "We are of opinion that, after the children have left the infant school, transitional methods should be adopted, which will develop their activity and train their powers by drawing in all cases, and by such other means as, for instance, modelling, or the collection and mounting of botanical specimens." . . . "If science is to be well taught, care should be taken, that where the ordinary teachers are not qualified, specially trained teachers should be employed." In respect to technical schools they say, "These schools, which should be the crown and development of elementary education, should be in touch and close sympathy through their management with our elementary school system."

IV. The proposals of the new Code also fall far short of what the principal School Boards are attempting. Spirited efforts are made in Birmingham, Manchester, Sheffield, Brighton, and other provincial towns, in establishing higher elementary schools with useful scientific teaching. The London Board determined from the commencement that object-lessons leading up to science subjects should be given in all its schools. It has repeatedly contended for the official recognition of such lessons; and it has lately sent a memorial to the Education Department asking that the regulation, at present in force in the infant schools, that, in assessing the grant, regard should be had "to the provision made for simple lessons on objects and on the phenomena of Nature and of common life," should be extended to the boys' and girls' departments.

The reforms decided upon by the London Board last year with the view of making the teaching more experimental and practical, and not so much a matter of book-learning as a development of intelligence and skill (see NATURE, vol. xxxvii. p. 577), are being gradually put into operation.

It has also for some years carried on a few classes for manual instruction in the use of tools with good success, but its efforts in that direction have been nearly paralyzed by the disfavour of the Legislature. This seems a necessary step towards the technical education which is now loudly called for (see Sir Henry Roscoe's lecture, NATURE, vol. xxxviii. p. 186); but in the new Code we look in vain for a word of encouragement.

Some of the larger Boards have carefully provided good instruction in natural history, and in the fundamental principles underlying mechanical, physical, and chemical science, for their pupil-teachers, though that does not appear upon the Government schedule.

V. What is wanted is a far more liberal recognition of the claims of science in elementary education. At present, object-lessons or certain sciences are, no doubt, recognized by the Code; but it is merely as an additional subject of instruction not comparable with the literary subjects which are considered essential, and which occupy the great bulk of the scholars' time. The knowledge of Nature is, in fact, totally neglected in hundreds or thousands of elementary schools, especially in country districts, where it would appear to be even more important than in towns. A boys' or girls' school can obtain the highest credit in the inspector's report, and the highest possible grant of money, without its scholars having ever heard of animal or plant, or of those materials of the world, or of those natural forces, with which the scholars will have to deal all through their lives. And what is perhaps still more anomalous, those pupil-teachers who are possibly expected to give object-lessons in their schools are never examined in natural history by the Department, and may gain a high place in their examinations without the least knowledge of any kind of natural science.

It seems most desirable that every little child who enters our schools should be led to observe and inquire; its curiosity and activity should be encouraged and directed; only when its senses have been made acquainted with things should it be introduced to the words by which they are called, first orally, then in writing or print. It should proceed from the concrete to the abstract, The works of the Creator are as worthy to be studied as the words of men, and should hold as high a place in any school curriculum.

The reply of the Department to such requests as these will probably be, We cannot assume that the teachers are capable of teaching or the inspectors of examining science. No doubt there is that difficulty. But many of them are capable, and they are all presumably intelligent men, who would easily learn what might be required of them. Special teachers of science also exist, and special examiners might be appointed. It may not be possible to insist on all these reforms at once, but at least encouragement should be held out to them, instead of the disappointing uncertainties of the Code now before Parliament.

J. H. GLADSTONE.

THE NATIONAL SCIENCE MUSEUM.

IT is now fifteen years since the Duke of Devonshire's Commission, in its fourth Report, made the following recommendations:—

"With regard to *the Scientific Collections of the South Kensington Museum*, we recommend:

"9. The formation of a collection of physical and mechanical instruments; and we submit for consideration whether it may not be expedient that this collection, the collection of the Patent Museum, and that of the Scientific and Educational Department of the South Kensington Museum, should be united and placed under the authority of a Minister of State.

"With regard to *Provincial Museums*, we recommend:

"10. That, in connection with the Science and Art section of the Education Department, qualified naturalists be appointed to direct the collection of specimens in order to supply whatever deficiencies exist in the more important Provincial Museums; and also in order to organize typical museums, to be sent by the Department of Science and Art into the provinces to such science schools as may be reported to be likely to make them efficient instruments of scientific instruction.

"11. That a system of inspection of Provincial Museums be organized with a view of reporting on their condition, and on the extent to which they are usefully employed, and whether the conditions of the loan or grant from the Department of Science and Art have been fulfilled."

It is quite in accordance with the general way in which scientific matters are treated by the British Government that practically nothing has been done to give effect to these recommendations. Committee after Committee has been appointed, but it would seem more to give an excuse for delay than anything else. But the apathy of the Government was not shared by H.M. Commissioners for the Exhibition of 1851, for some time afterwards they offered a large site on their estate, and a building to be erected at a cost of £100,000, if the Government would undertake its maintenance for the purposes named in the recommendations. Even this munificent offer was declined.

Again we hear that another Committee has been appointed. Its sailing orders are not known, but whatever they may be, it seems desirable to again place on record after an interval of fifteen years that part of the Report in question which relates to the inquiry intrusted to the Committee. The Report was the result of much and patient inquiry and deliberation (the Commission worked for five years), and that the competence of the Commission may not be doubted after this lapse of time, we give the names of the Royal Commissioners: the Duke of Devonshire, Sir John Lubbock, Sir James P. Kay-Shuttleworth, Dr. W. Sharpey, Prof. T. H. Huxley, Prof. G. G. Stokes, Prof. Henry J. S. Smith, and Mr., now Sir, Bernhard Samuelson. Mr. J. Norman Lockyer was the secretary of the Commission.

THE COLLECTIONS AT SOUTH KENSINGTON.

64. The South Kensington Museum is administered by a Director who is responsible to the Lords of the Committee of Privy Council on Education.

65. Though, from special circumstances, the art collections of this Museum have been, up to the present time, most developed, it has contained, from its earliest days, several collections of a scientific nature. Those at present existing are:—

(1) The food collection.
(2) The animal products collection.
(3) The structure and building materials collection.
(4) Models of machinery, ships, and military and naval appliances.
(5) Collections illustrating economic entomology and forestry.
(6) Collections illustrating fish culture.
(7) The educational collections.
(8) The Patent Museum.

66. *The Food Collection.*—This collection, which was commenced in 1858, has been formed with a view to showing, first, the chemical composition of the various substances used as food; secondly, the sources from which all varieties of food are obtained; and, thirdly, the various substances used for adulteration, and the best methods of detecting them.

A duplicate collection of the chemical analyses of food is used for circulation among country schools, and large descriptive labels are supplied to the managers of country museums who may apply for them.

67. *The Animal Products Collection.*—This collection was established by the Commissioners for the Exhibition of 1851, who observed that, whilst the public possessed, in the Museums of Kew and Jermyn Street, collections illustrative of the economic applications of mineral and vegetable substances, there was no representation of the uses of the animal kingdom. The collection consists of animal substances employed in textile manufactures and clothing; substances used for domestic and ornamental purposes; pigments and dyes yielded by animals; animal substances used in pharmacy and in perfumery; and the application of waste matters, together with illustrations of the processes of manufacture.

We have been informed that, for want of space, this collection has been but little developed of late years.

68. *Construction and Building Materials Collection.*—This collection had its origin in a large number of models and specimens which were presented to the Commissioners for the Exhibition of 1851 at its close. In 1859 the collection had become so extensive from gifts, especially from the Exhibitions in London and Paris, that the classified Catalogue formed a most useful book of reference on the subject, and was largely sold as such.

The collection consists of the following objects:—building stones; marbles and slates; cements and plasters; bricks of every description; tiles for roofing, flooring, and wall decoration; terra-cottas; drain-pipes; asphalte and bitumen; iron and metal work; woods applicable to building purposes; glass, and its application; models of buildings and construction; paper-hangings; *papier-mâché* work; architectural drawings and plans.

69. In connection with this Museum, numerous experiments on the strength of materials have been carried on, the results of which have been published in the Catalogues.

70. *Models of Machinery, Ships, and Military and Naval Appliances.*—This collection consists principally of models of marine engines, ships, and guns. But there are also specimens and models of machinery of a different character, such as the Jacquard loom, the Whitworth measuring machine, and the Babbage calculating machine.

71. *Collections illustrating Economic Entomology and Forestry.*—A collection of economic entomology is now in course of formation. It is intended to enable the public to distinguish insects injurious to man from those that work to his advantage, and to illustrate the best means of destroying those which are injurious, or of mitigating the ravages committed by them.

This collection, in its relation to forestry, contains specimens of the various kinds of timber attacked by insects, the insects themselves in various stages of

growth, and the appearance of the foliage and bark when attacked. The best known means of destroying the insects are also indicated.

72. *Collection illustrating Fish Culture.*—This collection illustrates the artificial breeding of fish, the protection of rivers, methods of capture of fish, &c. All or nearly all the collection belongs to Mr. Buckland (Inspector of Salmon Fisheries). It is on loan to the Museum.

73. *The Educational Collections.*—These collections comprise: (1) a library of books bearing on education in which education in science is largely represented; and (2) a collection of school furniture and fittings, philosophical instruments, apparatus for scientific and other instruction, specimens and diagrams of natural history, including mineralogy and geology, and other educational appliances, such as drawing materials, &c.

74. The origin of the library and collections is due to an Educational Exhibition formed by the Society of Arts, and held in St. Martin's Hall in the summer of 1854. When this Exhibition closed, many of the contents, English and foreign, were placed by the exhibitors at the disposal of the Society, and a strong desire was expressed that it should become a permanent institution. The collection thus formed was offered to and accepted by the Government.

75. The chief manufacturers of educational appliances and publishers of school books have largely contributed, and numerous gifts have been received from foreign Governments, especially at the close of the Exhibitions of 1862 and 1871. In consequence of the great demand for educational works on scientific subjects, the vote for purchases has of late years been largely expended in strengthening the library and collections in this direction.

76. Special collections of apparatus for teaching the various branches of science have lately been formed. Duplicate sets of these are circulated in the country.

77. The total number of books and pamphlets in the library exceeds 30,000.

78. A reading-room, ill-adapted and much too small for the purpose, as it has been stated in evidence, is attached to the library. It is open during the same hours as the Museum, and is chiefly frequented by students, teachers, clergymen, school-managers, and others who wish to consult special books, or to become acquainted with the best educational works on the various subjects.

79. *The Patent Museum.*—In connection with the South Kensington Museum, but under the control of the Commissioners of Patents, there is also a Patent Museum, consisting of a collection of patented and other inventions, ill-accommodated in a building which is much too small for the proper display of the objects. The collection belongs partly to the Commissioners of Patents, partly to the Commissioners for the Exhibition of 1851, and partly to private persons: it contains many most interesting specimens, especially a series illustrating the history of the steam-engine from its earliest days.

Proposed Additions to the Scientific Collections of the South Kensington Museum.

80. We consider it our duty to point out the striking contrast afforded by the British Museum collections, dealing with biology, geology, and mineralogy; the Jermyn Street collections, dealing with geology (scientific and economic), mineralogy, mining, and metallurgy; the Kew collections, dealing with botany, on the one hand; and, on the other hand, the collections in the Scientific Department of the South Kensington Museum (including the Patent Museum), where alone has any attempt been made to collect together, in a Museum, objects illustrating the experimental sciences.

81. While it is a matter of congratulation that the British Museum contains one of the finest and largest collections in existence illustrative of biological science, it is to be regretted that there is at present no national collection of the instruments used in the investigation of mechanical, chemical, or physical laws; although such collections are of great importance to persons interested in the experimental sciences.

82. We consider that the recent progress in these sciences, and the daily increasing demand for knowledge concerning them, make it desirable that the national collections should be extended in this direction, so as to meet a great scientific requirement which cannot be provided for in any other way.

83. The defect in our collections to which we have referred is, indeed, already keenly felt by teachers of science. If a teacher of any branch of experimental science wishes to inspect any physical instrument not in his possession, as a teacher of literature would a book, or a teacher of biology would a specimen, there is no place in the country where he can do it.

84. We are assured by high authorities that, on the Continent, collections of scientific apparatus, when combined with lectures accessible to workmen, have exerted a very beneficial influence on the development of the skill of artisans employed in making such instruments.

85. Lord Salisbury, in evidence before us, has stated:—

"There is another point in which I think that the Government might give an advantage of an educational kind to scientific research. It would be desirable, if it were possible, to provide the means of giving scientific instruction to instrument makers. My impression is that their importance to the conduct of scientific research is scarcely sufficiently recognized by the public, and that it is, I will not say quite, but almost of equal importance, to have highly educated and cultivated scientific instrument makers, as to have highly educated scientific thinkers."

86. A valuable part of the instruction to which Lord Salisbury refers would be derived from the examination of collections in which the history and latest developments of each instrument could be studied with a view to its improvement or modification in any particular direction.

87. On this point we have received interesting evidence from Colonel Strange:—

"What is your opinion as to the need of a museum of scientific instruments, and apparatus, and machines, and tools used in the arts?—I think that that is a very important branch of the subject indeed. I need scarcely allude to the great importance that is attached to that on the Continent. The name of the Conservatoire des Arts et Métiers will suggest it at once, which is the very best evidence indeed that I could produce. I have often visited it with great interest and profit. Moreover, I believe there are several others in Paris, some of more recent establishment, of the same kind; I look upon that as a most necessary part of any scientific system. No scientific system can be complete without examples of the apparatus that are being used in all branches of science, both in England and abroad, and on that point I speak from experience of the great use that such a museum would be. . . . If there were a great museum, such as I suggest, containing all the new developments in instruments, and in machines and tools, to which I could resort, I should be able to introduce modifications with far greater confidence, and it would be an enormous assistance to me individually. I find very few persons who have really studied what I will venture to call the physiology of instruments and apparatus, and such persons would derive very great advantage, I think, from being able to go to an establishment where large collections of apparatus of different dates and the products of different minds were collected together in one view, some of which would contain some desideratum of which they were in search. I think, if they had such a collection to go to, it would materially aid them in the choice of the apparatus

that they required, and would tend enormously to advance exact experiments. There is no doubt that some years ago there was no nation that could compete at all with England in such matters, but we have taught the rest of the world, and the pupil has now become somewhat in advance, in many directions, of his master. Also the spread of scientific education on the Continent has tended to the application of more sound principles of construction in such things than with us."

88. Although the question of the establishment of a Museum of Scientific Apparatus is more closely allied to the objects of our Commission than that of a Museum of Mechanical Inventions, we think it right to call attention to the proposals made by a Committee of the House of Commons appointed to report on the Patent Office Library and Museum.

89. That Committee gave, in the following terms, their conception of the nature of the "General Museum of Mechanical Inventions," the establishment of which they contemplated:—

"It appears to your Committee that the chief purpose of a General Museum is to illustrate and explain the commencement, progress, and present position of the most important branches of mechanical invention; to show the chief steps by which the most remarkable machines have reached their present degree of excellence; to convey interesting and useful information, and to stimulate invention."

90. With regard to the funds which would be necessary for the establishment of such a Museum on an adequate scale, the Committee, referring to a large sum which had accumulated from the fees paid by inventors (which fund, at the end of the year 1871, amounted to £923,741 8*s.* 11*d.*), stated that—

"Your Committee consider that the principal object of the fees payable under the provisions of the Patent Law Amendment Act, was to provide for the proper working of that measure, and not for the purpose of increasing the general revenue of the country. Without entering upon the question whether or not a claim exists to have the surplus exclusively devoted to the purposes of the Act of 1852, your Committee are of opinion that for the future the annual surplus revenue accruing from the operation of that Act should be so applied to the extent which may be necessary."

91. We agree with the Committee as to the general character of the objects to which the fund in question should be appropriated.

92. We consider that this fund, which is derived in great part from the applications of scientific principles to various uses in the arts and industries of the country, would be very properly spent in bettering some of the conditions on which invention and discovery depend: and we are of opinion that, among the uses to which such a fund could be most advantageously applied, the establishment of such a Museum of Scientific Apparatus as that which we contemplate would rank among the most important; and we are convinced that such a Museum would have a material influence upon the spread of scientific instruction throughout the country, and would therefore largely foster invention and discovery.

93. We accordingly recommend the formation of a collection of physical and mechanical instruments; and we submit for consideration whether it may not be expedient that this collection, the collection of the Patent Museum, and of the Scientific and Educational Department of the South Kensington Museum, should be united and placed under the authority of a Minister of State.

94. Whether this union be effected or not, we are of opinion that it is desirable that the scientific collections now placed at South Kensington should be subjected to a critical revision, with a view to restricting them to such objects as are of national interest or utility.

REPTILIAN ORDERS.

Catalogue of the Chelonians, Rhynchocephalians, and Crocodiles in the British Museum (Natural History). By G. A. Boulenger. New Edition. Pp. 311, Illustrated. (London: Published by the Trustees of the Museum, 1889.)

THE handsome volume before us deals, as its name implies, with all known existing forms of the three Reptilian orders of the Chelonians, Rhynchocephalians, and Crocodilians; but since the second group is represented only by a single species, while the number of Crocodilians comprises little more than a score of forms, the great bulk of the book is devoted to the Chelonians, and it will, therefore, mainly be this group to which our remarks will apply.

Previously to the appearance of this volume, the last systematic "Catalogue of Crocodilians and Rhynchocephalians" issued by the Museum was the quarto volume by the late Dr. Gray,[1] published in 1872; the next year having seen the publication of the revised list of Chelonians by the same author.[2] Without in any way wishing to disparage the labours of the late Keeper of the Zoological Department, to whose untiring energy the British Museum is so greatly indebted for its magnificent series of Reptiles, it is at once manifest that the present work is enormously in advance of any hitherto published, this advance being especially noticeable in the case of the Chelonians. Although in that order Dr. Gray figured a large number of skulls, yet the distinctive features afforded by this part of the skeleton were not accurately gauged from a taxonomic point of view, while the characters of the bony carapace, so far as they relate to the connections of the component bones with one another, were practically ignored. In this respect Mr. Boulenger has conferred a great boon, not only on the students of the Chelonia of the present day, but still more especially on those engaged in the study of fossil forms, who generally have to deal only with the more or less imperfect carapace and plastron. In almost every genus the author has caused at least one specimen to be stripped of its epidermal horny shields, so as to exhibit not only the impressions formed by the borders of these shields, but also the form and relations of the underlying bones which constitute the solid shell. And he has found that generic characters can be to a very large extent based on the structure of the skull, taken together with the form and relations of the bones of the shell; the contour of the neural bones of the carapace, and the relations of the suture between the humeral and pectoral shields of the plastron to the entoplastral bone being of especial importance. No less than seventy-three admirably-executed woodcuts serve to illustrate these osteological features, on which the taxonomy is so largely based; and by their aid the palæontologist may hope to clear up to some extent the affinities of the host of fossil Chelonians at present described under the vague terms of *Emys* and *Clemmys*.

The author proposes to divide the Reptiles treated of

[1] "Catalogue of Shield-Reptilia. Part 2. Emydosaurians, Rhynchocephalia, and Amphisbænians." (1872.)
[2] "Hand-List of the Specimens of Shield-Reptiles." (1873.)

in this volume into the following groups of higher than generic rank, viz.:—

Order **Rhynchocephalia.**
Fam. Hatteriidæ.

Order **Chelonia.**
Sub-order I. ATHECÆ.
Fam. 1. Sphargidæ.
Sub-order II. THECOPHORA.
Super-fam. A. *Cryptodira.*
Fam. 2. Chelydridæ.
3. Dermatemydidæ.
4. Cinosternidæ.
5. Platysternidæ.
6. Testudinidæ.
7. Chelonidæ.
Super-fam. B. *Pleurodira.*
Fam. 8. Pelomedusidæ.
9. Chelydidæ.
10. Carettochelydidæ.
Super-fam. C. *Trionychoidea.*
Fam. 11. Trionychidæ.

Order **Emydosauria.**
Fam. Crocodilidæ.

There are a few points in regard to the nomenclature of some of these groups where the author's views are at least open to question. This is especially the case with regard to the selection of the name Emydosauria to replace the almost universally accepted Crocodilia. The reason for the selection of this term appears to be, that it is the earliest. In common, however, with a large number of English zoologists, we (while deprecating the needless introduction of new ordinal names) hold that, although the enforcement of the rule of priority is, unfortunately, in most cases, obligatory as regards generic and specific names in order to avoid endless confusion, yet no such rule is necessary in respect to higher groups, where the name that has come to be generally used ought to be maintained. Then, again, the ungrammatically formed name Athecæ, for which Prof. E. D. Cope is responsible, should clearly have been amended to Athecata; while, since the name Thecophora—or, more correctly, Thecaphora—clashes with the same term employed for a group of Hydroid Zoophytes, we think the author would have been better advised had he followed his own article on Tortoises in the latest edition of the "Encyclopædia Britannica," and employed the term Testudinata in this sense. Finally, since the generic names *Hatteria* and *Sphargis* are rejected in place of the earlier *Sphenodon* and *Dermochelys* (which, by the way, should clearly be amended to *Dermatochelys*), we cannot follow the author in retaining the names *Hatteriidæ* and *Sphargidæ* for the families respectively represented by these two genera. If a family name means anything at all, it means a group of animals more or less nearly allied to a certain genus selected as the type, and it is therefore clearly illogical to call the *Sphenodon*-like reptiles *Hatteriidæ* when no such genus as *Hatteria* exists. Further, to show the absurdity to which this adherence to the rule of priority, in place of that of common-sense, in the case of family names might lead us, we have only to suppose that the name *Hatteria*, in place of being rejected as later than *Sphenodon*, had been rejected on account of being preoccupied by another form belonging to, but not the type of, a distinct family. In such case, we should have the family name *Hatteriidæ* for a group of animals which did not include the genus *Hatteria*! On these grounds we hold that the names *Sphenodontidæ* and *Dermatochelydidæ* should certainly replace *Hatteriidæ* and *Sphargidæ*.

In regard to the Rhynchocephalia, the author considers that its one existing representative indicates an extremely generalized type of reptile, of which the relations appear to be at least as close to the Chelonia as to the Lacertilia. In this respect, Mr. Boulenger departs very widely from the views of Prof. Huxley; and although we think he is undoubtedly justified in maintaining the Rhynchocephalia as a distinct order, yet we cannot overlook the circumstance that the Homæosaurian lizards of the Lithographic stone, which appear to be Rhynchocephalians, are most probably closely related to the ancestors of the Lacertilia.

The whole of the existing Crocodilians are included in a single family—against the three families adopted by Dr. Gray. The true Crocodiles are divided into *Crocodilus* and *Osteolæmus*, according to the absence or presence of a forward prolongation of the nasals to divide the anterior nares; while among the Alligators a similar feature serves to distinguish *Alligator* and *Caiman*. The *Crocodilus pondicerianus* of Gray is considered to be based upon a young specimen of *C. porosus*. The Gharial skull mentioned on p. 276 as having been obtained at Poonah would appear to be incorrectly labelled, as this reptile is unknown in Bombay.

Taking a brief general survey of the Chelonia, we think the author is fully justified in adopting Prof. Cope's division of the order into the two primary groups of Athecæ and Thecophora; the great difference in the structure of the skull, as exemplified by the absence of descending parietal plates in the former, being a character which is of itself apparently sufficient to uphold this division. We are aware, indeed, that Dr. G. Baur, of Newhaven, Conn., holds a precisely opposite view, and, in place of regarding the *Athecæ* as the most generalized type of existing Chelonians, looks upon them as an extremely specialized branch derived from the Cryptodiran *Chelonidæ*. There are, indeed, certain superficial, and probably adaptive, resemblances between these two types of marine turtles, but the fundamental differences are so great as apparently to render Dr. Baur's views untenable. And we should much like to ask that authority how he would explain the appearance of transverse processes to the dorsal vertebra of one of the extinct Athecæ on his own hypothesis of their phylogeny.

The three "super-families" into which the Thecophora are divided are, to a great extent, distinguished by the mode of flexure of the neck, by cranial characters, and by the relations of the pelvis to the shell. Certain very peculiar features in relation to the mandibular articulation, the tympanic ring, and the arrangement of the bones of the palate serve to distinguish the existing Cryptodira of the southern, from the Pleurodira of the northern hemisphere; but we have considerable doubts whether these characters will be found to obtain in the Mesozoic representatives of the group, and whether they are not rather acquired than archaic features. We should, indeed,

have been glad to have an expression of the author's views as to the mutual relations from a phylogenetic point of view of the three groups of the Thecophora; because, if the separate nasals and parieto-squamosal arch of some of the Pleurodira be indicative of their more primitive organization, it would be pretty clear that the peculiar specialized character of the mandibular articulation can only be diagnostic of the later forms.

The Trionychoidea, or soft Tortoises, appear to show affinities to the Pleurodira in the structure of the palate; and here again we miss an expression of opinion as to the nature of this relationship. The peculiar chevron-shaped entoplastron, which is regarded as an important diagnostic feature of the group, was, we believe, first brought prominently to notice by Dr. Baur.

In regard to the families of the Cryptodira, the author follows Dr. Gray in regarding *Staurotypus* as nearly related to the *Chelydridæ*, but places it in a distinct family, of which *Dermatemys*, placed by Dr. Gray next the Batagurs, is taken as the type. *Cinosternum*, likewise placed by Dr. Gray in the *Chelydridæ*, is regarded as the type of another family, readily characterized by the absence of the entoplastral bone; while the *Platysternidæ* is likewise a family of which but one genus is known. The widest departure from the arrangement of Dr. Gray is, however, found in the case of the *Testudinidæ*, which is a very extensive family, embracing the *Emydidæ* of other writers, and no less than four other families of Dr. Gray's "Hand-List." The transition from one genus to another is, however, so gradual, as apparently to afford full justification for the new departure. Twenty genera of this family are recognized, all of which can be defined by characters of the skull and shell. We would especially note the disappearance of the well-known *Pangshura* of India in the genus *Kachuga;* and would also remark that, after its complex synonymy, the common European Pond Tortoise is finally to be known as *Emys orbicularis*. The genus *Testudo* is the largest in the whole order, comprising no less than forty-one species. Here it has been found that the division of the pygal, or supra-caudal, shield is a character commonly occurring in the typical *Testudo græca*, and consequently *Testudo emys*, which, on this account was made the type of the genus *Manuria*, and has attained an unfortunate notoriety owing to the controversy regarding *Scapia*, is included in the type genus. The *Chelonidæ*, or Turtles, are divided into the genera *Chelone* and *Thalassochelys*, each of which is represented by two species. And here we may notice the wise discretion of the author in refusing to recognize a host of so-called species based on features which may well be regarded as merely indicative of varieties. The members of this family, it may be remarked, are the only existing Thecophora in which the temporal fossæ are completely roofed over by bone; and since a more or less complete approximation to this feature occurs in many Mesozoic types, this bony roof may perhaps be regarded as indicative of direct affinity with some of these early types. In the Pleurodira the first two families are distinguished from one another by the presence or absence of a mesoplastral bone, as well as by well-marked cranial features, while the third family, represented only by the aquatic *Carettochelys* of New Guinea, has no epidermal shields on the shell. This remarkable form, it may be observed, is one of the few desiderata in the collection of the Museum.

In the Trionychoidea, all of which are included in the family *Trionychidæ*, the author has, we believe for the first time, pointed out characters by which the skull of the typical forms, in which the hyoplastral remains distinct from the hypoplastral, can be readily distinguished from that of the group typically represented by *Emyda*, and characterized by the fusion of the above-mentioned bones. In the diagnosis of the genera *Trionyx*, *Pelochelys*, and *Chitra* on p. 241, we meet with the following sentence, viz. "outer extremities of the nuchal bone overlying the second dorsal rib." This sentence, when contrasted with the corresponding diagnosis of the three following genera, strikes us as liable to lead to confusion; and the sentence would be better if it read "outer extremities of the nuchal bone overlying the rib supporting the first costal bone." It appears, indeed, that the first dorsal rib of Chelonians is aborted, and carries no costal bone, or plate, so that the first costal bone is supported by what is really the second rib. We may perhaps be pardoned for pointing out that the term "*straight* angle," mentioned in the fifth line from the bottom of p. 251 does not, at first sight, suggest the idea of a "*right* angle," for which, we presume, it is meant.

Scarcely any systematic work can nowadays escape criticism, but in our judgment the system adopted in the present volume appears to be one which in the main ought to meet with very general acceptation, and we heartily congratulate the author on the completion of a very laborious task in a manner which deserves the thanks of the students both of recent and fossil Chelonians. R. L.

THE HISTORY OF ANCIENT CIVILIZATION.

The History of Ancient Civilization. By the Rev. J. Verschoyle, M.A. (London: Chapman and Hall, 1889.)

THE title of this book is somewhat misleading. One is led to expect from it a history of the growth of civilization from its earliest stages to its various developments among different nations or races, and of the relation of one form to another. But instead of this we have an account of the characteristic civilization of certain selected nations when at their best, with very little to indicate any relation between them. The nations whose civilization is described are the Egyptians, the Babylonians, and Assyrians; the Jews, Phœnicians, Aryans, and Persians; the Greeks and the Romans. The two latter are treated very fully, occupying about three-fifths of the whole. There can be no question that the information conveyed would be very useful to a student of ancient civilization, but he would immediately ask for more. If he had any intention of studying the question from a scientific point of view, he would not be content with isolated facts, but ask for the connection between them. Indeed, one of the most conspicuous features of the book is the complete absence of any scientific method; its merits must be appreciated entirely from the literary

standpoint, especially in connection with the history and literature of Greece and Rome.

In any scientific history of civilization, the first stages, in which from rough stone implements men passed to the arts of drawing, sculpture, and the manufacture of pottery, and so to the invention of bronze and the erection of megalithic buildings, are surely of too much interest to be dismissed in a sentence or two, with an illustration of a "flint spearhead" of very peculiar appearance. To what races these men might belong we do not learn from our author, who, after observing that "modern science has also directed its attention to the subject of races and anthropology, and has issued in studies which have not, however, yet resulted in a decisive conclusion," dismisses all other races in eighteen lines, and springs on us the "white race," "whose first habitation was the highlands of Asia." "It was there that, after the deluge chronicled in the legends of all Eastern nations, mankind dispersed, and formed the three chief branches of the white race—the families of Ham, Shem, and Japhet." Thus we learn nothing about the remarkable and early civilization of the Chinese, on the ground that "the information respecting it is not sufficient." We are not, therefore, surprised that the author dismisses America with the single sentence, "In America, the copper or red race has continually receded before the Europeans, and cannot be counted amongst the civilized races." He apparently thinks there has never been but one race in America, and forgets the ancient civilization of the Aztecs, and that of the race which they themselves succeeded; and we cannot therefore hope that he will throw any light on the home of that remarkable people who carved the idols of Easter Island, or erected the megaliths of Tonga.

In the chapter on Egypt there is much interesting though somewhat disconnected information; but those who think that the arts and sciences are amongst the most important parts of civilization, will perhaps scarcely be satisfied with the statement that "the scientific theory, which would consider the pyramid a kind of observatory, is quite unfounded."

The materials for the description of the civilization of the cities of Mesopotamia are so rich that the chapter which deals with it cannot fail to be interesting; it is only to be desired that the relations of the Accadians, Babylonians, and Assyrians, and their several conditions, had been made more clear, and the great length of time, as in the case of the Egyptians, over which the same type of civilization continued, pointed out. Indeed, one of the remarkable features of ancient civilization, which has an important bearing on the antiquity of man, is its slow progress.

The account of Eastern civilization, or that of the Aryans and Hindus, is very defective. Indeed, we have little more than a short account of the tenets of Brahmanism and Buddhism, and no mention of their art, though many of the Hindu stupas and topes date back before the Christian era. There is some fair description of Persian and Phœnician civilization, but there is nothing about the Phrygians. The rock tombs of Asia Minor are unnoticed, and Troy is only mentioned in relation to the Greeks.

In contradistinction to this, the treatment of Grecian and Roman history is superabundantly full, as one sentence will show. "The 'epithalamium' of Mallius is probably his best work, always excepting his charming lyrics to Lesbia." If a notice of so little known a poet forms part of the history of ancient civilization, it is difficult to see why the omissions above enumerated should occur.

In a word, the whole subject is unequally treated; there is a bias towards classical learning, which, in spite of the useful information given, prevents the book from being in any sense a scientific history.

OUR BOOK SHELF.

Board School Laryngitis. By Greville Macdonald, M.D. Lond., Physician to the Throat Hospital, Golden Square. Pp. 31. (London: A. P. Watt, 1889.)

NUMEROUS as are the evils to which the Board School system is alleged to have given rise, we have before us yet another indictment to add to the list. This time, however, it is the teachers, and not the scholars, who compel our interest. Dr. Macdonald claims to have identified certain changes in the vocal apparatus of Board School teachers, of both sexes, of so definite a character as to enable him to state with certainty from the appearance of the throat that the patient belongs to that long-suffering class.

A varicose condition of the superficial vessels of the vocal cords and a nodular hypertrophy of the free margins are the conditions to which he calls special attention. Of the latter condition he notes that it may occur without obvious inflammatory surroundings, and quotes Stoerk's reference to it under the name of "singers' nodules." He does not, however, mention the Viennese laryngologist's explanation of them, which, in the present connection, is interesting. Stoerk claimed that these nodules were the direct result of an improper use of the voice, whereby a part only of the vocal cords was set in vibration. The nodules made their appearance at the spot intervening between the vibrating and the motionless parts of the cords, usually the junction of the anterior third with the posterior two-thirds.

Board School teachers, uninstructed for the most part as to the use of the voice, depressed by the close and often foul atmosphere of a crowded schoolroom, choked with the chalk from their blackboards, and often compelled to scream to make themselves heard above the din of an unruly class, are beset with every condition which predisposes to inflammation and over-straining of their vocal apparatus.

Dr. Macdonald suggests remedies for such a state of things, for the consideration of the ruling powers, and intimates that local treatment alone is of any avail in dealing with the changes to which he calls special attention. The varicose vessels he would destroy with the galvano cautery, and the nodules with the forceps. The monograph is written in a fluent and readable style, and treats of a subject which deserves the serious attention both of lay and professional readers. Possibly the interest of the latter class would have been more keenly aroused had the author appended a little more information as to the extent of his experience. He tells us that the Board School teachers consult him in increasing numbers, and that his success in treatment has been remarkable, but he does not quote cases, or offer any statistical record, by which his professional brethren may compare his experiences with their own in the same line of practice.

The pathological conditions to which he would affix such an attractive title are not by any means unknown as a consequence of chronic laryngitis in other walks of life, and something more than mere assertion must be offered before they can be generally accepted as the peculiar product of the Board School system.

E. CLIFFORD BEALE.

A Treatise on Elementary Algebra and Algebraical Artifices. By Saradaranjan Ray, M.A. Two Vols. (Calcutta : S. K. Lahiri and Co., 1888.)

THE work under review is also Part II. of "A Course of Elementary Mathematics." Vol. I. comprises those portions of elementary algebra usually to be found in modern text-books up to the chapter on proportion. Vol. II. includes chapters on variation, theory of equations, elimination, binomial theorem, and properties of logarithms, as well as many others ; but those mentioned will suffice to show the general scope. The author gives the object he has had in view : "To create in beginners a taste for algebra, and to show them the utility and application of algebraical artifices." In achieving this desire he has met with some degree of success. The language employed is simple and clear. The proofs in many instances are interesting. We question the advisability of placing the binomial theorem and properties of logarithms at the conclusion of a work which contains biquadratic equations. At least an elementary chapter upon the former subject should precede the theory of equations, while a discussion of logarithms would be of great use in its development.

We notice one very important omission : the multinomial theorem finds no place in these volumes. This is much to be regretted, for the chapter on permutation could have introduced it in an elegant and suggestive manner. Again, we notice that the subject of series is scarcely touched upon. One would hope in a work of this scope to find a short chapter which would include reversion of series. However, there are many excellent features in the book. Chapters on "Consistency and Sufficiency," and on "Identities and Equalities," are novel and gratifying. The pages concerning arithmetical and geometrical progressions are original and inspiring ; for example, the student is taught the meaning of the sum of n terms of a progression when n is negative, and is shown that both arithmetical and geometrical progressions possess the common property that two successive terms are connected by a linear relation ; from this point of view the series are then further examined.

There are many examples, as a rule well selected, with occasional hints to show the learner that a little ingenuity will often overcome particular difficulties. There are a few occurrences of faulty printing, and some misprints which do not appear in the errata.

The students of our Eastern dependency are in possession of a book by one of their own countrymen who is a thorough master of his subject.

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.*]

The Sailing Flight of the Albatross.

IN NATURE, vol. xxxix. p. 230, the late Mr. William Froude, in a letter to Sir William Thomson, on the subject of the "Soaring of Birds," gives a short account of the well-known and often discussed sailing flight of the albatross ; and says that after long consideration the only explanation which presented itself to his mind was, that the birds use the upward current caused by the lifting of the air from the bottom of the trough to the level of the crest of an advancing wave. Mr. Froude by a rough calculation—the waves being supposed 10 feet from hollow to crest—concludes that an upward current of 3 feet per second may be caused in this manner, and states that the bird's movements were often in accordance with this explanation, though it was often impossible to affirm or deny the accordance.

Having had many opportunities of observing the flight of the albatross, I cannot think this explanation the true one. I have often seen albatrosses sailing when the sea appeared as flat as a table, with the exception of the small waves caused by a light wind. This seems fatal to Mr. Froude's explanation, which requires waves of considerable size. As Mr. Froude observed, the birds often sail along the crests of waves. It seemed to me that they were sometimes using the current diverted upwards by the wave, just as on land birds use that diverted by hedges, river-terraces, &c.

I will first give a description of the flight of these birds, as I observed it when on board steamers running between Australia and New Zealand, which are nearly always followed by numbers of birds ; and then attempt an explanation. The sailing flight is never to my knowledge done in a calm. I once observed the effect of a gradually diminishing wind on their flight. The steamer was going about nine knots. When the wind, which was very nearly aft, became one or two knots slower than the steamer, the birds, which had hitherto kept their wings perfectly steady, began to flap at intervals which became shorter as the wind lessened, and when it ceased they flapped almost without intermission, and soon ceased to follow the vessel.

The birds go through a series of movements which are related to the direction of the wind. Starting from near the surface, they rise in a slanting direction against the wind, to a height which varies with the strength and direction of the wind. The average seemed to me about 20 feet. Then comes immediately a turn half round in a rather large circle, followed at once by a rapid descent down the wind. They then take a longer or shorter flight in various directions, almost touching the water. After that another ascent in the same manner, and so on, repeating the series of movements *ad libitum*. The interval of time between the ascents evidently depends on the direction of the wind with regard to the course of the vessel. When the wind is ahead, and the birds' velocity through the air great, being necessarily greater than the wind's velocity plus that of the steamer, the interval is short. When the wind is abaft the beam, and the birds' velocity much less, the interval is usually much longer. As a general rule, there is a rough proportion as to the favourableness of the wind and the length of time between successive ascents. Also, when the wind is favourable and not strong they do not rise so high as in a strong and adverse wind.

The explanation I have to give of the movements above described depends upon the well-known fact that the velocity of the wind at the surface is diminished by friction, so that its velocity increases with the height, the *rate* of increase being greatest near the surface. Prof. Osborne Reynolds found by experiment that the wind's velocity over a grass meadow at a height of 8 feet was double that at 1 foot.[1] Over the sea, when there is enough wind to roughen the surface, the drag on the lowest stratum is probably greater than over a grass meadow, on account of the motion communicated to the water. This effect of friction makes clear the object of the ascents against, and the descents with, the wind. For, as a bird rises, he enters currents of wind which increase in velocity with the height, in a direction contrary to his own motion, so that the loss of velocity consequent on rising, and which would take place in still air, is partly —or perhaps, when the wind is strong, wholly—made good. The bird thus gains energy of position, which is converted into energy of motion by descending. A bird's ascent against the wind may be compared with the ascent of a particle up an incline, while the incline itself is accelerated in a horizontal direction opposite to that of the particle's motion, thereby enabling it to reach a height greater than that due to the initial velocity. The albatross does not go on rising until his velocity is nearly exhausted, but makes a half-turn at great speed previous to his descent. Thus the quickness of the ascent, with, as Mr. Froude says, scarcely if any apparent loss of speed, is explained. By making a slanting descent with the wind, the bird carries with him the velocity of the faster-moving wind of the high level into the slower-moving wind near the surface ; and thus increases his velocity through the air, to which is to be added that due to his fall. Thus, if resistance is left out of account, the bird's velocity since he began to ascend would have been increased by twice the difference in the velocity of the wind near the surface, and at the height to which he rises. And as the power of overcoming resistance varies as the square of the velocity, the addition of several feet per second to the bird's already high velocity is equivalent to much more energy than is lost in the few seconds occupied by the rise, turn, and fall ;

[1] "On the Refraction of Sound by the Atmosphere," by Prof. Osborne Reynolds. Read before the Royal Society, April 23, 1874.

so that there is a clear gain, which may be expended in flight until the speed is so much reduced that it is necessary to increase it by another ascent.

The reason is clear why, when following a steamer against the wind, the birds are compelled to repeat at short intervals the movements by which speed through the air is gained, and why, when the wind is favourable, the intervals are longer. The great length of these intervals just mentioned seems to me the difficult point in the theory. It cannot be proved that the speed acquired by the movements described is sufficient for such long flights between the ascents as are sometimes seen, under conditions where there is no suspicion of upward currents near the surface. Our knowledge of the resistance of the air to such complex surfaces as the wings of birds is, I believe, almost nothing; and even if we knew, without doubt, the true explanation of the manner in which the energy lost by resistance is renewed, we might find it hard to apply it to all cases, unless we had some real knowledge of the supporting power of the air, and the horizontal resistance at different velocities.

I have sometimes seen a number of albatrosses sailing in a peculiar manner, the wind being at right angles to the course of the steamer. They ascend against and descend with the wind, turning alternately right and left, so as to describe an undulating line, not far behind the stern. A number of them sometimes do this for hours, while others are sailing in various directions farther off. It is curious that the common sea-gulls of New Zealand (*Larus dominicanus*), which have become to a great extent land-birds since the country was colonized, may be sometimes seen making their way over flat country in the same manner as the albatrosses just described—that is, at right angles to the wind, and turning alternately right and left, and nearly touching the ground at each descent. Their success in doing the sailing flight is, however, imperfect, as they seem compelled to flap their wings a few times during the second half of each ascent. Perhaps future generations of gulls may improve. No doubt some muscular exertion is saved by this mode of progression. The foregoing theory of the sailing flight of the albatross shows, I think, the action of a *vera causa*, which, as far as I know, has not been noticed before. A. C. BAINES.

Christchurch, New Zealand.

Note on *Ragadia crisia*.

MR. W. L. DISTANT, in his admirable "Rhopalocera Malayana," calls attention to the recent appearance of *Ragadia crisia* in the Malay peninsula. As I have had opportunities of studying the habits of the species in what seems to be one of its head-quarters, it may be desirable to record the facts.

Mr. Distant writes as follows:—"One of the most peculiar facts in relation to this butterfly seems to be its almost recent appearance in the Malay peninsula, or at all events its first capture there by collectors. I did not meet with it myself when collecting at Province Wellesley, nor did I subsequently receive it in numerous collections derived from the peninsula. In 1883, however, the species seems to have been common from Penang to Singapore. I first received two specimens captured on Penang Hill, and sent to me as a new species; others shortly followed from Province Wellesley, with the remark of an experienced collector that the species was quite new to the locality; and almost simultaneously the Indian mail brought me more examples from Sungei Ujong, Malacca, and Singapore. My friend Mr. Logan also sent me an example with the comment, 'a very rare butterfly not known to collectors here.'

"Capt. Godfrey, who also captured the species at Sungei Ujong, described it as being found in low undergrowth in the forest, where, especially in the early morning, I several times met with it. Its flight is weak and feeble, but it cleverly eludes pursuit by threading its way through tangled brushwood" ("Rhop. Mal.," p. 421).

Mr. W. B. Pryer, in his joint paper with Mr. Distant ("Rhop. Northern Borneo," *Ann. Mag. Nat. Hist.*, January 1887, p. 49), describes it as "rare, under almost thick forest shade." In ten years' collecting in North Borneo he has only met with a few specimens, not more than a dozen, nearly all of which he saw at Silam, on the coast of the district I write about.

I find it to be the very commonest butterfly in the dense forest of the centre of Darvel Bay Peninsula, on the east coast of British North Borneo.

I first saw the insect in the deep forest between Lamag on the River Kinabatangan and Itok Batu on the River Segama, about 120 miles inland. It was not common, but I always saw one or two daily. Since then Mr. Pryer has taken it higher up the River Kinabatangan, some 250 miles up stream. The butterfly is still quite rare on the coast, the only specimens having fallen to Mr. Pryer's net.

Last year I made an exploration through the forest from the River Tinkyo in Darvel Bay to the head-waters of the River Segama. Within four miles of the coast, in the alluvial flat of the River Tinkyo, the species was seen daily, but was far from common. As soon as we touched the mountain country it began to grow common, and from 600 feet to 2500 feet above sea-level it was the commonest butterfly in the deep forest.

Capt. Godfrey's description of its habits agrees with mine, except in one particular. He found it most plentiful in early morning. I was always in the jungle from soon after dawn to near dusk, and found it appeared about 9 o'clock in the morning, and was on the wing till about 4 o'clock in the afternoon.

It has the feeblest (and wickedest) flight of any butterfly known to me. I never saw it rise six feet above the ground, and it flaps slowly along, apparently with effort, its wings not stiff but bending with each stroke. It *looks* a certain capture; but this, as Capt. Godfrey found, is delusive and elusive. It keeps just above the low bushes from two to three feet high, and sneaks in among them most exasperatingly. It seems to do this deliberately, and will rather circuit round an opening made by a fallen tree than cross the small opening. It is often seen flying in rain.

As a rule it is quite solitary, it being rare to see two at once, and it is not at all bold or pugnacious.

Its wings are so soft that it often crumples in the wet, and it is almost impossible to set it during the rainy season, the wings relaxing in a few hours, though it may have been a week on the setting-board.

From February to October it was equally common. I then came out of the forest. It probably flies all the year round.

It is one of the few true forest species, and avoids the sunshine.

I do not know whether the insect is common elsewhere, and can offer no suggestion as to why it should be spreading from this part, though it is undoubtedly creeping coastwards. The eastern part of North Borneo is untouched primæval forest, the only clearings being on the coast and river-banks, and these are small. The country where *Ragadia* abounds is quite uninhabited, and it is difficult to see how the food-plant (unknown) could have been taken thence to the Straits Settlements. Then too, in Borneo at any rate, it would avoid clearings.

Leaving this question for future observers to solve, we now know that in one part of the interior of North Borneo *Ragadia crisia* is very common, and it is extending its area.

SYDNEY B. J. SKERTCHLY.

Spherical Eggs.

PROF. ALDIS will find references to the history of this ancient question in an article by Mr. W. Walton in the *Quarterly Journal of Mathematics*, vol. ix. p. 79, where it appears as Leslie Ellis's problem of the thirsty crow. "A thirsty crow flew to a pitcher and found there was water in it, but so near the bottom he could not reach it. Seeing, however, plenty of small, equal spherical pebbles near the place, he cast them one by one into the pitcher, and thus by degrees raised the water up to the very brim and satisfied his thirst. Prove that the volume of water must have been to that of the pitcher in a ratio not less than $3\sqrt{2} - \pi : 3\sqrt{2}$." References are supplied in the article by the Rev. Dr. Luard to Pliny's "Natural History," book x. chapter 43, "De Corvorum Intelligentiâ"; Plutarch, "De Solertiâ Animalium; and Ælian, "De Naturâ Animalium." Consult also Tait's "Properties of Matter."

Thus in an aggregation of closely-packed equal spherules the unoccupied space is $1 - \frac{1}{6}\pi\sqrt{2}$ of the whole volume.

We may verify this experimentally by comparing the weight of a given volume of small lead shot with the weight of an equal volume of lead; theoretically the densities should be as π to $3\sqrt{2}$.

On a larger scale, the question may be studied in the piles of spherical shot formerly to be seen in our forts and arsenals. Whether we begin piling the shot in horizontal layers, in triangular order, or in square order, the internal molecular arrangement of the spheres is the same; but the square order in the horizontal layers is preferred, as it is then possible to build the pile on a rectangular base, finishing off at the top with a ridge

of balls in single file, the sloping faces all showing the spheres in triangular order.

Suppose a bag, impermeable to water, is filled with lead shot, placed in an hydraulic press, and subjected to great pressure. The lead spheres will be flattened against each other in regular cell structure into a solid mass, each sphere being changed into a *rhombic dodecahedron*; and in this manner the form of the cell of the bee has been considered as arising in a natural manner by Mrs. Bryant, D.Sc., in a paper read before the London Mathematical Society, vol. xvi., "On the Ideal Geometrical Form of Natural Cell-Structure." The plane surfaces of separation also form a possible arrangement of the films of a mass of soap-bubbles; but the instability of the corners where six edges meet modifies the soap-bubble arrangement to the form investigated by Sir W. Thomson in the *Acta Mathematica*.

April 27. A. G. GREENHILL.

Name for Unit of Self-Induction.

A NAME for the unit coefficient of self-induction is much wanted. No one is satisfied with secohm, and yet it seems making its way; by reason, no doubt, of Ayrton and Perry's ingenious commutating arrangement for helping to measure it. It is an unpleasing name, and it is too big a unit. The name quad, which I formerly suggested, is on further consideration still less satisfactory for permanent use, because it emphasizes unduly the accident that *in electro-magnetic measure* self-induction happens to be a length. One looks forward to the time when all distinction between electrostatic and electro-magnetic measures shall vanish by both ceasing to be; and at that not far-distant time, names emphasizing the present arbitrary state of things will be anachronisms, as well as stumbling-blocks to beginners. I beg to suggest that a milli-secohm shall be called a *vo*. It is a short and harmless unmeaning syllable not yet appropriated. It should be its own plural. The unit of conductivity is already styled a *mo*; and 8 vo will look well alongside 12 mo. "Vo-meter" is short and satisfactory. A unit of magnetic induction will then be the vo-ampere; and this, being of a size convenient for dynamo makers, may be hoped to replace their abominable mongrel unit "Kapp-lines."

The vo in electro-magnetic measure is 10 kilometres, and hence a vo ampere per square decimetre is a magnetic field of a thousand C.G.S. units, and might be called a "Gauss." For lightning-conductor work the natural unit of self-induction will be a milli-vo, or 10 metres of electro-magnetic measure.

Grasmere, April 16. OLIVER J. LODGE.

Hertz's Equations.

PERMIT me to add a line of explanation of my letter on this subject, printed in NATURE, vol. xxxix. p. 558. I intended no criticism of Hertz's general result, but merely to draw attention to the necessity of rejecting all solutions of the equation in Π which made the force (Z) infinite for points on the vibrator.

Berkswell, April 24. H. W. WATSON.

A NEW PEST OF FARM CROPS.

DURING the past three or four years, in the examination of plants affected by various injurious worms and Arthropods, and of the soils in which such plants grew, I have from time to time been led to suspect that certain small species of *Oligochæta* were concerned in damaging, if not ultimately destroying, several species of cultivated plants. With a view to converting suspicion into proof, experiments on isolated growing pot-plants have been carried on.

Within the past few weeks I have received, through the kindness of Miss E. A. Ormerod, additional evidence of a striking character, which induces me to place the main facts on record.

In the spring of 1885, Miss Ormerod forwarded to me for inspection two small white *Oligochæta*, 1½ inch long, received by her in soils from the roots of plants. In reporting on them I replied that it did not seem very probable that they could seriously injure the plants.

In April 1888, an inquiry reached me as to the nature and means of prevention of a serious attack of "small white worms" destructive to pot and green-house plants. On being placed in communication with the observer, the Rev. William Lockett, Rector of Littledean, I received from him a box of soil taken from his affected flower-pots, and much valuable information in answer to a series of questions put by me. The soil itself contained some hundreds of the white worms described; and the detailed information all pointed to these worms as the cause of many serious losses which had been sustained.

The worms were Enchytræidæ, of the genus *Enchytræus*, apparently near to *E. Buchholzii*, Vejd. I took three plants, a sunflower, a geranium, and a tradescantia, and had them re-potted in carefully examined sifted earth; when they were well established, I put fifteen of the worms into each pot, and left them to be tended by the gardener. I kept a number of the worms in soil which was alternately wetted and dried at regular intervals. They all kept alive and vigorous; when wet to complete immersion they were most active, when dried they remained quiescent, apparently dried up, and difficult to discover.

After two months, the sunflower drooped and bent over, and examination showed the roots and rootlets dead and the stem rotting. Within the decaying stem some of the Enchytræidæ were found alive and active. The other two plants are still living, but it will be shown that the number of worms supplied them was too small. Mr. Lockett lost spiræas, vegetable marrows, fuchsias, gloxinias, and many other plants, and the dead roots often contained in and around them many hundreds of worms to each plant. Both in his garden and a neighbouring ash-heap he found an abundance of them.

I was on the point of repeating my experiments this spring with various seedlings, when I received by the kindness of Dr. Gilbert, of Rothamsted (at the suggestion of Miss Ormerod), a quill with two or three specimens of worms of the same genus. Mr. John J. Willis, the superintendent of the field experiments at Rothamsted, in sending them described them as obtained from a field of clover "with a good plant except across one portion of the field, where all the plants were dying off," the small worms occurring at the roots of the clover along with larvæ of *Sitones* and wire-worm. "There is scarcely a plant that has not one or more of these creatures attached." Mr. Willis has been good enough to send me several communications on the subject, and a supply of the worms, living and in spirit. Much of his information is interesting, as that the more decayed the root, the larger the number of worms; that even healthy plants harbour a few specimens; that the worms seem sometimes to enwrap the rootlets with their coiled body. He hears of other fields of clover in a similar condition apparently to those at Rothamsted. I have a quantity of detailed information, but to summarize it, there appears to be but little room for doubt that these small *Oligochæta* are one cause of the decay of the clover at Rothamsted, as they were of the many varieties of garden plants at Littledean.

The Enchytræidæ have not hitherto, so far as I can learn, been accused of causing serious injury to plants. Vejdovsky, in his "Monographie der Enchytræiden," says, "Die Enchytræiden bewohnen trockene und feuchte Erde, süsses und salziges Wasser, Sümpfe und morsches Holz." In what manner they directly injure the plant remains to be observed—probably by sucking the fine root-hairs. Under observation the pharynx is rapidly everted and withdrawn in the act of feeding. I have so far recognized two species. If, as seems not improbable, further corroboration should be forthcoming, we may find that we have to add to the list of enemies of the clover plant from which it so mysteriously suffers, these unsuspected Oligochætes. The discovery, though fraught

with so little satisfaction to the already burdened agriculturist, can hardly fail to prove of interest to the zoological student of farm pests.

ALLEN HARKER.

Royal Agricultural College, Cirencester, April 10.

RAIN CLOUDS ON LAKE TITICACA.

THE cloud system here, 12,500 feet above sea-level, is so beautiful, and seems to throw so much light on the formation of one particular type of shower, that I venture to send diagrammatic sketches of two excellent specimens of cloud-building over rain.

I have never seen cumuloform clouds so perfectly developed as on this lake. Whether the height above the dust and haze of lower levels makes the blue sky darker than usual, or whether the temperature is such that the cumulus is composed of snow-flakes instead of water-drops, the contrast between the sky and cloud is much greater than usual.

The sketches were taken on a showery day, and the clouds were visible simultaneously in different directions. The type of shower is not unknown at home, but there much complication arises from the almost constant existence of cyclonic cloud systems.

Certain features are common to both pictures. Nearest the earth, appears a more or less conical-shaped space *r*,

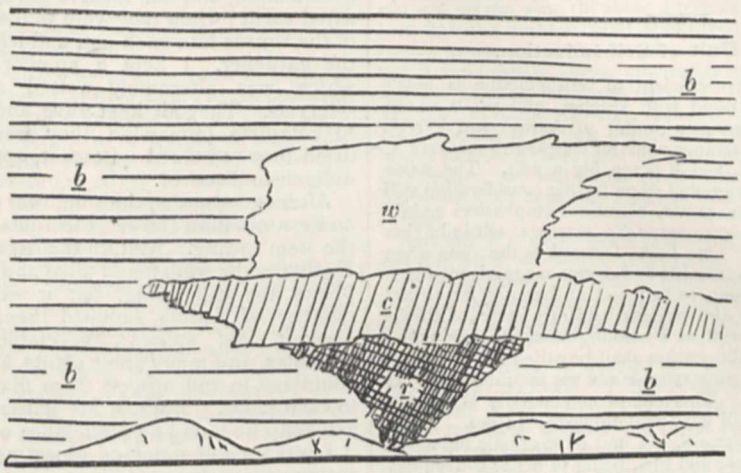

FIG. 1.—*b*, blue sky; *c*, flat-topped mass of dark cloud, rounded components; *r*, rain; *w*, white cloud, tending to flatten out and to cirrify.

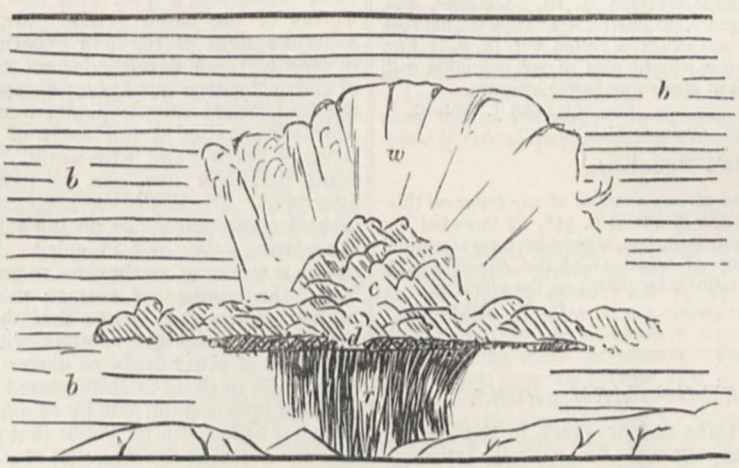

FIG. 2.—*b*, blue sky; *c*, dark cumuloform cloud, flat-topped at edges; *d*, dark belt; *r*, rain; *w*, white cloud, tending to flatten and to cirrify.

of uniform inky blackness, where rain is falling. Above, and stretching laterally some distance beyond the rain, is a belt of dark cloud, *c*, curiously flattened at the top; but the outlines are always *rounded*, and there is no trace of linear or hairy structure. In Fig. 2 a mountainous rocky cumulus rises above the flat dark mass *c*; and as the rain could be seen falling, I have indicated that appearance in the sketch.

In both, a white cloud, *w*, of remarkable shape and structure, rises above the dark mass *c*. Sometimes, as in Fig. 1, this cloud is nearly uniform in structure, but exhibits a tendency towards hairy structure at the edges. Other times, as in Fig. 2, the white cloud *w* shows traces of cumuloform structure of a very peculiar type. Instead of round, rocky lumps, the white cloud is composed of long, straight, fingery masses of cumulus, with a tendency to fibrous or hairy structure, and radiating slightly outwards from the base, like the head of a cauliflower. I have endeavoured to suggest this appearance by the straight lines, drawn through *w*, in Fig. 2; for the real structure defies delineation with pen or pencil.

In all cases, the top of *w* is more or less flat, and the whole diffuses outwards, sideways, or edgeways, rather than upwards. As the shower breaks up, *w* seems to be left as a middle-level layer of strato-cirrus.

The whole shower is surrounded by blue sky, there is

no cirrus at a higher level; and while the low cloud *c* moves from north-east, the white cloud *w* may be coming either from north-east or more probably from north-west.

The puzzling nature of cloud perspective makes it very difficult to interpret the appearance of these clouds. There can be little doubt that the lower clouds, *c*, are the product of the condensation of rising columns of air; but while the somewhat cumuloform structure of *w* ought also to indicate an upward motion, the flat top, and outward diffusion, would suggest a more horizontal motion. I cannot therefore suggest any rational explanation of the building of these shower clouds; and the true nature of this phenomenon will only be discovered when the theodolite is used to determine whether *w* lies vertically or horizontally in the blue sky.

RALPH ABERCROMBY.

Lake Titicaca, February 28.

A FLAT FISH NURSERY.

PROF. EWART submitted the following report at a recent meeting of the Scotch Fishery Board:—

"I have to report that I recently discovered in the inshore waters what might best be described as a flat fish nursery. This nursery, which is about five miles in length, and from two to four miles in width, stretches along an exposed and only slightly indented shore, where the sea rises during spring tides from sixteen to twenty feet. The bottom of this area consists chiefly of fine sand, covered here and there with large patches of the common sea-mat (*Flustra*); the average depth is about four fathoms. When a small beam-trawl (with a net having meshes small enough to capture all the fish over two inches in length) was carried over the bottom parallel to and at a distance of about half a mile from the shore, large numbers of small flat fish were invariably secured. On one occasion as many as five hundred and sixty of these small fish were taken in less than an hour, and at all times the 'take' was large, and usually from 80 to 85 per cent. of the small flat fish were under two and a half inches in length. Some distance from the shore the takes were smaller, and on one occasion the trawl only secured twenty-three small fish, when used in about ten fathoms of water, some seven miles from shore. Along with the small flat fish, there were usually a few small round fish, a number of shrimps —sometimes over, sometimes considerably under one pint —numerous hermit and other crabs, and large quantities of *Flustra*. As it may be possible to materially increase the fish supply by affording protection to the young fish, I hope to be able ere long to report that other similar nurseries have been found, and also as to whether flat fish during their earlier stages of growth frequent the inshore in preference to the offshore waters.

"I have also to report that Mr. Scott (who in January last secured many thousands of plaice eggs floating in the open sea over a shoal of spawning plaice) has recently come across a large shoal of spawning haddocks which were apparently resting on the bottom at a depth of about 30 fathoms some fifteen miles off the coast of Banff. The surface waters over the shoal were crowded with haddock and cod eggs at nearly all stages of development. At a single sweep Mr. Scott with his tow-net secured nearly half a million eggs, while the trawlers were capturing hundreds of the spawning fish that were resting on or moving about near the bottom."

NOTES.

THE annual *conversazione* of the Royal Society will be held on Wednesday, May 8.

AT a meeting of the American Academy of Arts and Sciences on April 10, in Boston, the Rumford Medals were presented to Prof. Albert A. Michelson.

WE regret to have to record the death of Mr. R. Stirling Newall, F.R.S., at the age of seventy-seven. Mr. Newall's name was well known in connection with the invention and manufacture of wire rope and telegraphic cables. Just before his death he offered as a gift to the University of Cambridge the 25-inch refracting telescope which he had constructed some years ago.

THE Civil Service Estimates for the year ending March 31, 1890, show that a sum of £41,221 will be required for the maintenance of the Natural History Museum, South Kensington, for the present financial year. The corresponding sum in the Votes last year was £40,934. The principal increase is under the head of "Purchases and Acquisitions," for which the sum asked is £4700 instead of £3700. On the other hand, there is a decrease of £915 under the head of "Furniture and Fittings." The remaining heads do not show any material variation.

DR. LENDENFELD'S "Monograph of the Horny Sponges," which the Royal Society are about to publish, is now nearly through the press. It will consist of about 950 pages of text and over 50 plates.

WE have received the Report of the Mason Science College, Birmingham, for the year ended February 23, 1889. It is hardly creditable to Birmingham that the authorities of such an institution as this should still have to complain of a deficiency of income. Although the amount of the deficiency compares very favourably with those in former years, the Council feel that the economies they have been forced to adopt in order to decrease the difference between income and expenditure seriously impair the College work by hampering the Professors, especially those who have laboratories under their charge and require costly apparatus to illustrate their teaching.

PROF. H. G. SEELEY, to whom a sum was assigned from the Government Grant for a research on the Permian or Trias Reptilia, has been spending his Easter recess in St. Petersburg and Moscow. The officers and professors of the Academy, the University, and the School of Mines at St. Petersburg have shown him every attention, and his work in the museums appears likely to lead to important results.

MUCH excellent work has been done by the London Geological Field Class, which is carried on under the direction of Prof. H. G. Seeley. The Report relating to the excursions during the summer of 1888 shows that the work is conceived in a thoroughly scientific spirit, and that it cannot fail to exercise a most wholesome intellectual influence on all who take part it. This year, on account of Prof. Seeley's projected visit to South Africa in July, the class will begin its labours earlier than usual. The first excursion will take place on May 4. Many persons interested in geology ought to take advantage of this opportunity for the study of the country around London, and we are glad to learn that the secretaries have received the names of more subscribers than they have received at the same date in any previous year.

MR. DUTHIE, the Government Botanist for Northern India, who has been at work with Dr. King, of the Howrah Botanical Gardens, in classifying the plants collected by him when attached to the Black Mountain Expedition, has now been directed by the Government to make a special study of the grasses and fodders of Upper India.

THE *Times of India* says that the Sukkur Bridge, which has been constructed over the Indus, has now been opened. At Sukkur the river is very rapid, but the large island of Bukkur, standing about midway in the stream, was of great assistance in carrying out the plans. There are thus two bridges, one from Bukkur to the left bank, the other from Bukkur to the right bank. The latter consists of three spans, the longest of which is 278 feet; the former, known as the Sukkur Bridge, is in length between the abutments no less than 790 feet. Two cantilevers,

310 feet long, one from each side, were erected, and the intervening space of 200 feet was crossed by a girder. There was thus a space between the pillars of 820 feet, which is said to be the largest span of any rigid bridge in the world. The weight of the span is 3300 tons. The bridge was sent out in pieces from the works of Messrs. Westwood, of Poplar, and now, sixteen months after the arrival of the materials from England, it is practically complete.

A CORRESPONDENT writes to us about a "find" which, he thinks, may prove to be of some interest. At Hornsey, near Turnpike Lane, an excavation—about 18 or 20 feet wide, and about 20 feet deep—is being made in connection with a new pumping-station. In cutting into the clay, the men have come upon large fragments of a white substance, in the inside of which are what appear to be "the vertebræ of some animal." Our correspondent expresses a hope that some one competent to form an opinion about the matter will "take a run down to Turnpike Lane" (near the Great Northern station at Hornsey), and examine the objects which he believes to be fossils. After the present week, he says, there will probably be no opportunity of seeing the clay in the state in which it was when the objects were removed from it.

AT the meeting of the Scientific Committee of the Royal Horticultural Society, on April 23, Mr. W. T. Thiselton Dyer presented a note from Mr. Scott, the Director of the Meteorological Office, relating to the "useful" temperature as reckoned in "day degrees," and to the amount of sunshine since January 1 of the present year, as compared with recent years. The present season, it seems, has been much better than the last, except as regards the amount of sunshine, in which there is not much improvement.

SIR JAMES HECTOR has issued the Meteorological Report for New Zealand, containing observations for the years 1883 and 1884. Returns have been published since 1853, but since the year 1880 the number of stations has been greatly reduced, in favour of current weather reports; the principal stations are now only four in number. With the view of enabling daily weather reports to be issued by the press throughout the colony, with the least possible expense, a series of twenty typical isobaric charts were prepared and are shown in the Report. Each represents a certain type of weather and bears a distinguishing number, which is telegraphed to the leading journals, so that when the number for the day is quoted, the diagram can be printed, and, although not absolutely correct, it is of great assistance in making known the general condition of the weather. The Report also contains some valuable returns from stations in the Fiji group of islands.

A NEW amine, methyl-ethylamine, $C_2H_5(CH_3)NH$, has been obtained by Drs. Skraup and Wiegmann, by the action of alcoholic potash upon morphine. Not only is the actual preparation of this hitherto unknown amine of importance in itself as completing a series of isomers of the formula C_3H_9N, but the fact of its derivation from morphine also throws considerable light upon the constitution of that alkaloid. It has been shown by several chemists that morphine, $C_{17}H_{19}NO_3$, is a derivative of phenanthrene, $C_{14}H_{10}$. As a methyl and an ethyl group have now been extracted in the form of an amine, it appears very likely that these groups are present in morphine, replacing two hydrogen atoms of phenanthrene and probably attached to nitrogen. If this be so, morphine may turn out to be the isonitrile of a substituted phenanthrene, and it remains now for future work to test the truth of this, and to determine the positions and functions of the oxygen atoms. In the latter connection, it was found in the course of this investigation that, in addition to the volatile amine, a second substance of phenol-like properties was also formed, but great difficulties were met with in its purification. In the actual experiments, morphine was heated for about five hours at 180° C. with ten times as much of a twenty per cent. solution of potash in alcohol. A volatile substance of amine-like odour was evolved, and was driven over by means of a current of coal gas into dilute sulphuric acid. The filtered acid solution was then supersaturated with soda and the purified amine distilled over in steam into a standard solution of hydrochloric acid. It was only found possible to eliminate from the morphine in this way about 50 per cent. of its nitrogen. The concentrated hydrochloric acid solution deposited crystals of a hydrochloride, and the solution also gave with platinum chloride crystals of a platino-chloride melting at 208°. Analysis of this latter salt showed that the amine present possessed the empirical formula C_3H_9N. There are four possible isomers of this formula, three of which, trimethylamine, propylamine, and isopropylamine, have been prepared; and methyl ethylamine, which has hitherto been unknown. The hydrochloride yielded the base itself, by action of the strongest potash, in the form of a clear liquid of intense amine odour, unlike, however, that of trimethylamine. The properties of its salts were also found to exclude the possibility of its being propyl- or isopropylamine, so an attempt was made to prepare synthetically the only other possible isomer, methyl-ethylamine. This was successfully accomplished by heating methyl iodide with a mixture of 30 per cent. ethylamine solution and alcohol in a sealed tube at 100° for three hours. The product was distilled as far as possible in steam, the residue decomposed with potash, and the remainder of the volatile amines driven over in steam. The aqueous solution of the mixed distillate was then shaken with ethyl oxalate, and successive products were obtained, on concentration, of diethyl oxamide, acid ethylamine oxalate, and, lastly, the oxalate of the sought-for base, methyl-ethylamine. This salt, when recrystallized, melted at 154°, like the oxalate prepared from the amine derived from morphine; and from it the hydrochloride, platinochloride, gold chloride, and free base were prepared, in every case the products being identical with those prepared from the base of morphine.

MESSRS. SMITH, ELDER, AND CO. have issued a third edition of Darwin's work on "Coral Reefs." To this edition Prof. Bonney contributes an appendix, giving an account of recent speculations—about which there was lately so much discussion in NATURE—as to the origin of coral reefs.

A CHEAP edition of Darwin's "Journal of Researches into the Natural History and Geology of the Countries visited during the Voyage of H.M.S. *Beagle* round the World," has been published by Mr. Murray. The portrait of Darwin which appeared in the NATURE series of "Scientific Worthies" is prefixed to this edition.

MESSRS. CHARLES GRIFFN AND CO. have published a sixth edition of "A Pocket-book of Electrical Rules and Tables for the use of Electricians and Engineers," by John Munro and Andrew Jamieson. The work has been thoroughly revised, and enlarged by about 120 pages and 60 new figures.

SOME valuable contributions towards a Flora of Caithness, by J. F. Grant and Arthur Bennett, have been reprinted from the *Scottish Naturalist*. The number of species and varieties that are admitted for the county of Caithness is over 600, a fair number, the authors think, considering the physical features of the county. Caithness has about 80 species that have not yet been found in Sutherland, and about the same number not yet found in the Orkneys.

THE Smithsonian Institution has issued six lithographs illustrative of the anatomy of *Astrangia Danae*. The plates were drawn by Mr. Sonrel, in 1849, under the direction of Prof. Agassiz, who intended to prepare a complete memoir on the subject. Mr. J. Walter Fewkes has written an explanation of the plates to make them available to students of marine invertebrates.

A NEW number of the *Internationales Archiv für Ethnographie* has been issued. It consists of Parts I. and II. of the second volume; and the contents, as in every preceding number of this excellent periodical, are full of interest for students of ethnography. There are three long articles—all in German. In the first, Dr. F. von Fuschan gives an instalment, carefully illustrated, of a paper on an amusement popular in Turkey, corresponding to the magic lantern. The second is an elaborate essay, also illustrated, by Dr. H. Schurtz, on knives made in various parts of Africa for the purpose of being thrown. In the third article, Mr. R. Parkinson, of New Britain, brings together many valuable ethnological facts relating to the inhabitants of the Gilbert Islands.

THE "Uses of Plants," by Prof. G. S. Boulger, which is about to be published by Messrs. Roper and Drowley, is a manual of economic botany, having special reference to vegetable products introduced during the last fifty years. It enumerates all vegetable substances in use in England as food, materia medica, oils, gums, rubbers, dyeing, tanning, and paper-making materials, fibres, timber, &c., both home-grown and imported; and there are short essays on the recent progress of vegetable technology in its various branches.

IN a Report lately received, Mr. W. Fawcett, Director of Public Gardens and Plantations, Jamaica, gives an interesting account of a visit of a few days to the Cayman Islands during May 1888. In an appendix he gives a list of the plants he collected, for the determination of which he expresses indebtedness to the authorities at Kew. "From this list," says Mr. Fawcett, "it will be seen that about 20 per cent. of the species are found more or less throughout the tropics. They are such as one might expect to find on any tropical island. It is interesting to note that one of the ferns (*Acrostichum aureum*) which is found growing to a height of 6 to 10 feet in swamps in Jamaica and throughout the tropics, was one of the first plants to establish itself on the Island of Krakatão, where the terrible volcanic disturbance completely destroyed every vestige of plant life. On its shore was also found the fruit of another plant occurring in the Cayman Islands, viz. the almond tree (*Terminalia Catappa*)."

AT a recent meeting of the Royal Asiatic Society of Japan, a paper was read by Dr. Seymour on the hygiene of Japanese houses, in which he disproves the common idea that dwelling-houses in that country are very unhealthy. A Japanese house, is, on the whole, suited to Japanese life. The extreme airiness of the structure prevents the charcoal fires doing the inhabitants any injury. Its chief defects can be easily remedied. The boarding of the floor can be made more close-fitting; ventilating panels should be used; the ceilings could with advantage be higher, and the drainage should be well looked after. Amongst foreigners there is distinctly more illness in brick and stone houses than in the wood or frame houses, on account of the damp remaining in the walls of the brick houses while it dries up almost immediately in the others. The remarkably small infant mortality amongst the Japanese shows that their houses are healthy and suited to their modes of life.

MR. F. A. HERON has been appointed an Assistant in the Zoological Department of the British Museum, not in the Geological Department, as stated (by a printer's error) in NATURE, vol. xxxix. p. 590.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀), from India, presented by Mr. J. G. Mackie; two Caracals (*Felis caracal*) from Bechuanaland, presented by Captain Treville Cookson; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. William Shiell; a Long-eared Owl (*Asio otus*), European, presented by Mr. Thomas B. Batler; three Orbicular Horned Lizards (*Phrynosoma orbiculare*) from Mexico, presented by Mr. T. H. Collins; a Rhesus Monkey (*Macacus rhesus* ♀), four Concave-casqued Hornbills (*Dichoceros bicornis* ♂ ♂ ♀ ♀) from India, a Crowned Hornbill (*Anthracoceros coronatus*) from Malabar, a Nepalese Hornbill (*Aceros nepalensis*) from Nepal, deposited; a Peacock Pheasant (*Polyplectron chinquis* ♂) from British Burmah, a Squacco Heron (*Ardea ralloides*) from Southern Europe, purchased; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♀), a Derbian Wallaby (*Halmaturus derbianus* ♀), born in the Menagerie.

OUR ASTRONOMICAL COLUMN.

THE APRIL METEORS.—Few of the April meteors appear to have been visible this year. They were watched for by Prof. Herschel at Croydon, Mr. Denning at Bristol, Mr. Backhouse at Hurworth (near Darlington), Mr. Monck at Dublin, and other observers. The shower of Lyrids was but weakly represented, and meteors generally were scarce. Several conspicuous ones were, however, recorded from the secondary streams of the April epoch. On April 20, at 10h. 16m., a meteor equal to Sirius was seen between Corvus and Virgo by Mr. Backhouse, and at the same time Prof. Herschel recorded a second-magnitude in Perseus. A comparison of the two paths shows the objects to have been identical, and the heights of the meteor at its beginning and end points, as computed by Prof. Herschel, were 50 and 46 miles respectively (over Derbyshire), which is much lower than usual. The radiant-point was at 301° + 34°. Another brightish meteor was seen on April 21, at 10h. 16m., by Prof. Herschel and Mr. Denning, and its heights were from 76 miles above a point near Newport, Monmouthshire, to 60 miles near Brecon. The radiant was at 217° - 2°, near μ Virginis. A fine meteor, quite equal to Venus, was observed at Bristol on April 27, at 8h. 51m., slowly descending in Hercules. Its path was from about 218° + 49½° to 249° + 32¼°. It left a trail of sparks as it fell, and its lustre fluctuated in a remarkable manner.

THE WHITE SPOT ON SATURN'S RING.—Prof. Holden reports that a careful examination of the ring of the planet with the great Lick equatorial on several evenings from March 2 to March 24 has resulted in the detection of no abnormal appearance in it. A kind of yellowish deformation or lump was indeed noticed close to the shadow on two or three occasions, but it proved to be due partly to bad definition, for it was only seen when the air was unsteady, and partly to contrast, for a similar appearance was produced in any part of the ring by the use of an occulting bar.

THE VARIABLE X CYGNI.—Mr. Yendall gives a new determination of the elements of this variable in *Gould's Astronomical Journal*, No. 191. Discovered by Mr. Chandler in 1886, it has proved a variable of very interesting character, and its light changes still require much study. The rise from minimum to maximum is generally sharp, but the interval varies much in length, the range being from 3·3 days to 8·7 days; the mean interval being 6·9 days. The curve is flat at minimum, and from these two circumstances Mr. Yendall has confined himself to the use of the maxima alone in the determination of his new elements. The decrease from maximum to minimum shows a remarkable halt, sometimes a positive rise, almost important enough to be considered a secondary maximum. Lastly, the magnitude touched at the extreme points of the curve varies from epoch to epoch, but with a general correspondence between the two phases, a bright maximum being accompanied by a bright minimum, and the contrary. A connection between the duration of the rise and the brightness at maximum has not yet been established. The elements given by Mr. Yendall are—

1886 October 10d. 6h. 11·8m. Camb. M.T. ± 52·3m. +
16d. 9h. 36m. 51s. ± 2·3s. E.

PHOTOGRAPHIC DETERMINATION OF THE BRIGHTNESS OF THE STARS.—No. 7 of vol. xviii. of the *Annals of the Harvard College Observatory* details the progress of the researches in stellar photography carried on at that institution by the assistance of the Bache fund, the particular direction in which the inquiry is being carried on being the determination of stellar magnitudes by means of photography. The present work is concerned with the determination of the brightness of the stars in three particular regions, each with special qualifications for the functions of standard stars; viz. 1100 close circumpolar stars, 420 stars in the Pleiades, and over 1100 equatorial stars. These three catalogues have been prepared with great care; the errors of the different photographic plates fully examined, and the relation of photometric to photographic magnitude investigated. The work

therefore forms a most necessary and valuable introduction to a complete survey of the heavens on the same method. The instrument used was the Voigtländer photographic doublet, of 8 inches aperture and 44 inches focal length, so that the scale of the photographs was that of the atlas of the *Durchmusterung*, 2 centimetres to a degree. The images of the stars obtained on the plates were of different kinds, the clock sometimes being employed to drive the telescope when the stellar images were points or disks, sometimes the clock was stopped when trails were obtained, sometimes the clock was used but trails produced through the polar axis of the telescope not being parallel to that of the earth; indeed the adjustment of the polar axis was made in this way. The standard for measuring the stellar points was a photograph of the Hyades, the plate being exposed six times with exposures of 3 seconds, and 3^2, 3^3, to 3^6 seconds respectively. For measuring trails a plate was exposed to the polar region, and the aperture of the telescope varied to correspond to successive differences of a magnitude. The result of the careful and independent measurements of the plates showed that the measures of a skilled observer of the same star disk or trail did not vary on the average by so much as a tenth of a magnitude; so that if the errors due to the photographs themselves can be eliminated the photographic method of determining stellar magnitudes is at least as efficient as the best photometric methods. The comparison of the diurnal with the clock trails showed that the correction for declination to be applied to the former was only half 2·5 log cos δ, the value it should have had if the chemical action due to a certain amount of energy was independent of the time during which it acted.

The first of the three catalogues given in this work is that of the stars within 1° of the pole. Rectangular co-ordinates are given with the stars, instead of R.A. and declination. Of the 1009 stars included, 947 are within one degree radius from the pole, and nearly all are above the fifteenth magnitude. The catalogue of the Pleiades includes all of Wolf's stars between 3m. preceding, and 2m. following Alcyone, and 30′ north and 15′ south of that star with a few apparently overlooked by Wolf. The equatorial catalogue contains the stars within 2° of the equator. Ten different fields were photographed on each plate, one being exposed on the meridian, eight others right and left at intervals of 40m. hour angle, and the tenth on the polar region. A comparison of the results obtained brings out some interesting points. Tempel, at Marseilles, observing the Pleiades with a 4-inch telescope, reached fainter stars than Wolf at Paris with 12 inches aperture. The behaviour of photographic lenses of different apertures shows that to double the aperture is to command two additional magnitudes; to treble it, two and a half. A 24-inch aperture should, therefore, grasp stars below the seventeenth magnitude. A comparison of the photographic magnitudes with the Cordoba Catalogue, and the *Durchmusterung* gives distinct maxima for the residuals in the Milky Way, showing that the Catalogue magnitudes are too faint near the Galactic stream where stars are numerous.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 MAY 5–11.

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

At Greenwich on May 5

Sun rises, 4h. 26m.; souths, 11h. 56m. 32·0s.; daily decrease of southing, 5·1s.; sets, 19h 27m.: right asc. on meridian, 2h. 50·7m.; decl. 16° 23′ N. Sidereal Time at Sunset, 10h. 22m.

Moon (at First Quarter on May 8, 7h.) rises, 7h. 57m.; souths, 16h. 17m.; sets, 0h 35m.*: right asc. on meridian, 7h. 11·7m.; decl. 22° 41′ N.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.
	h. m.	h. m.	h. m.	h. m. ° ′
Mercury..	4 44 ..	12 43 ..	20 42 ...	3 37·3 ... 20 51 N.
Venus ...	3 44 ...	11 24 ..	19 4 ...	2 17·8 ... 17 59 N.
Mars ...	4 52 ..	12 44 ..	20 36 ...	3 38·2 ... 19 47 N.
Jupiter ...	23 46*...	3 42 ...	7 38 ...	18 35·2 ... 22 57 S.
Saturn ...	10 32 ...	18 11 ...	1 50*...	9 6·6 ... 17 47 N.
Uranus...	16 46 ...	22 15 ...	3 44*...	13 10·7 ... 6 48 S.
Neptune..	5 18 ..	13 4 ...	20 50 ...	3 58·3 ... 18 52 N.

* Indicates that the rising is that of the preceding evening and the setting at of the following morning.

May.	h.	
5 ...	17 ...	Mercury in conjunction with and 1° 9′ north of Mars.
7 ...	22 ...	Saturn in conjunction with and 1° 28′ south of the Moon.

Saturn, May 5.—Outer major axis of outer ring = 41″·0: outer minor axis of outer ring = 11″·6: southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Dec'. ° ′		h. m.	
U Cephei	0 52·5 ...	81 17 N. ...	May 6,	1 52	*m*
			,, 11,	1 31	*m*
X Boötis	14 18·9 ...	16 50 N. ...	,, 10,		*m*
δ Libræ	14 55·1 ...	8 5 S. ...	,, 6,	23 51	*m*
W Herculis... ...	16 31·3 ...	37 34 N. ...	,, 6,		*m*
U Ophiuchi... ...	17 10·9 ...	1 20 N. ...	,, 6,	2 30	*m*
			,, 6,	22 38	*m*
U Aquilæ	19 23·4 ...	7 16 S. ...	,, 11,	1 0	*M*
S Vulpeculæ ...	19 43·8 ...	27 1 N. ...	,, 8,		*m*
η Aquilæ	19 46·8 ...	0 43 N. ...	,, 0,	1 0	*M*
S Sagittæ	19 51·0 ...	16 20 N. ...	,, 6,	22 0	*M*
S Aquilæ	20 6·5 ...	15 18 N. ...	,, 10,		*m*
X Cygni	20 39·0 ...	35 11 N. ...	,, 7,	2 0	*M*
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	,, 11,	23 0	*m*
δ Cephei	22 25·1 ...	57 51 N. ...	,, 8,	21 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near ϵ Crateris	170° ...	10° S. ...	Very slow.
,, η Ophiuchi	255 ...	20 S. ...	Slow; long.
,, ζ Draconis	260 ...	64 N. ...	Slow.

GEOGRAPHICAL NOTES.

THE discovery is announced of a new mouth of the Zambesi, forty-five miles south of the Quaqua, on which Quillimane is situated. The name of the river is Chindé. As we know already of a Chindé River which joins two of the principal mouths of the Zambesi, the probability is, not that a new mouth has been discovered, but that an already known mouth has been more completely explored. The Chindé, it seems, has a channel some 500 yards wide, with three fathoms of water at the lowest, and is therefore expected to afford a clear waterway to the main Zambesi.

FOR the last few years Baron Nordenskiöld has been engaged on a work of great importance in the history of geography, and especially of cartography. He has been collecting from the archives of various European countries specimens of the earliest printed (as distinguished from manuscript) maps, and some of his finds are really original discoveries. These he intends to reproduce in a great atlas with accompanying text, in which, among other things, he will describe and discuss the various editions of Ptolemy; of these he has formed a unique collection. The work will appear both in a Swedish and an English edition.

THE country of Oklahoma, about which we have heard so much during the past fortnight, is in the very heart of what is known as the Indian Territory, which lies between Kansas on the north and Texas on the south. Although on the Survey maps of the United States it seems to be well watered, the actual results would show that the water is not well distributed. It is traversed by the Canadian and Cimarron rivers, and between them are found on the map a perfect network of streams. The area of Oklahoma is a little over 3000 square miles, equal to about one-twentieth of the total area of the Indian Territory; the number of Indians in the latter is about 80,000.

IN an article in the May number of the *Fortnightly Review*, by Mr. F. C. Selous, the well-known South African hunter and explorer, we find a useful account of Mashonaland, around which at present there is so much interest. No man knows the country so well as Mr. Selous, who during the past ten years has traversed it in all directions. Mashonaland lies to the north-east of the Matabele country, and is described as a land of perennial streams, where thirst is an unknown quantity. The high plateau, which is of very great extent, forms the watershed between the Zambesi to the north and east, and the Limpopo and the Sabi

to the south; it is from 4000 to 4600 feet above sea-level. Nearly the whole of it is magnificently watered by a network of running streams, the springs supplying which well out from the highest portions of the downs, so that an enormous area of land could be put under irrigation. The whole year round a cool wind blows almost continuously from the south-east, a wind which in the winter months becomes so cold that it may well have its origin among the icebergs of the Antarctic seas. The country, Mr. Selous assures us from his own experience, is admirably adapted for European occupation and labour. The soil is rich and fertile, and from the facilities for irrigation enormous quantities of wheat could be grown. Although the highest and healthiest parts of the country are very open, still one is never out of sight of patches of trees. Besides the high plateau of Mashonaland, the whole of which is over 4000 feet above sea-level, extending along the watershed for a distance of over 200 miles from the Matabele country to the source of the Hanyane and Mazoe Rivers, with a breadth of from sixty to one hundred miles, there is a vast extent of country lying to the south, east, and north-east of the plateau, well-watered and fertile, having an altitude of from 3000 to 4000 feet. These plateaus are of much ethnological interest, as giving shelter to the very few remnants of the peaceful Mashonas that have escaped extermination at the hands of the bloodthirsty intruders, the Matabele.

MR. SELOUS leaves England for the Cape to-morrow. It is possible that he may be compelled to lead a prospecting party up the Zambesi. Should this not be the case, he is likely to proceed northwards bevond the Zambesi to the Garenganze country, west of Lake Bangweolo, and thence make either for the source of the Lualaba, which he will endeavour to follow down until it broadens out into the Congo.

M. J. TAUPIN, Professor in the College of Interpreters at Saïgon, has completed an important exploration in the lower Laos country. Starting from Saïgon in October 1887, M. Taupin, after visiting the Siamese province of Siem-Reap, and photographing the numerous Khmer remains in that province, notably those of Angkor, crossed the forests of the lower Laos, to Ubon, where he resided several months. Among other things he has obtained a knowledge, at least summary, of the Laotian language and writing, the only graphic-alphabetic system, it is stated, on which we have no positive information. The language, M. Taupin states, is spoken by four million people. He has surveyed about 1000 kilometres of rivers and watercourses not found on any map, besides making many important corrections. He has made many notes on natural history, and experimented with the culture of European plants. The meteorology and anthropology of the country, moreover, received much attention at his hands.

AT the next meeting of the Geographical Society, on May 13, the evening will be mainly occupied with a discussion of Mr. Stanley's letters, in which several well-known African authorities are likely to take part.

CAPTAIN BINGER, a French explorer, has succeeded in filling up one of the blanks on the map of Africa. Starting from the banks of the Niger, he penetrated the country of Kong, amid many dangers and sufferings.

THE HENRY DRAPER MEMORIAL.[1]

THE researches which constitute the Henry Draper Memorial have consisted for the last three years in the photographic study of the spectra of the stars. While this subject will continue to be the principal one under investigation, Mrs. Draper has decided to extend the field of work undertaken, so as to include the study of the other physical properties of the stars by photography. As will be seen from the detailed statement below, the first research undertaken is now rapidly approaching completion, the plans for the study of the southern stars have been matured, and this study will soon be begun; the detailed study of the spectra of the brighter stars is making progress, and a large piece of photometric work will soon be undertaken with a new telescope. The progress made in each investigation will now be described, as in previous Reports.

1. *Catalogue of Spectra of Bright Stars.*—The Bache telescope, which has an 8-inch photographic doublet as an objective, is used for this work. The photographs cover the entire sky north of −25°, with exposures of about five or ten minutes. About 28,000 spectra of 10,800 stars have been examined, including nearly all stars visible in Cambridge of the seventh magnitude or brighter. The Catalogue is now nearly ready for the printer, the final copy having been prepared as far as 14h. in right ascension.

Nearly the entire time of three or four computers has been devoted during the past year to this work. The intensity of about 15,000 of the spectra has been measured, completing this part of the research. Much time has been spent in checking and verifying the results. All the positions have been checked and brought forward to 1900 two or more times independently. All discordant measures have been re-examined, and a search has been made for possible error when bright stars are omitted or very faint ones inserted. Seven thousand two hundred notes have been made on the various stars in the Catalogue. Each note has an appropriate number which permits it to be entered in its proper place. Most of these notes relate to additional lines contained in these spectra besides those by which the type is determined. The position and intensity of these lines is estimated. A portion of them have been reduced to wave-lengths. The printing of the Catalogue might have been already begun but for the difficulty of deciding how the different types of spectra should be distinguished. The classification used for visual observations fails to indicate many differences obvious in the photographs. On the other hand, the photographic portions of spectra of Types II. and III. are nearly identical. The photographs also show many stars whose spectra are intermediate between those of the typical stars which have determined the usual classification. A system has, however, been adopted which permits all differences detected in the photographs to be described in the printed volume.

Thirteen spectra were found on these plates which could not be identified with stars. Three of these proved to be due to Mars, one to Vesta, three to Jupiter, four to Saturn, and two to Uranus. Accordingly all the exterior planets bright enough to be detected in this way appear on these plates.

The measures of the intensity of the spectra form a very important portion of this work. Since the same part of the spectrum is measured in each case, the true relative energy is determined. That is, the same result is obtained as if the measures of rays of the same wave-length were made by any other method, as photometrically by the eye, by the thermopile, or by the bolometer. The colour of the star will be indicated by the extent of the spectrum, which is also noted. For the first time, therefore, we shall have a photometric Catalogue in which the error due to the colour of the star is eliminated. A preliminary determination of the accordance of the results derived from different photographs of the same star shows that the average value of the residuals will be about 0·16, which is the same as the corresponding quantity for the Harvard Photometry. The number of stars is more than twice that contained in the latter Catalogue.

2. *Catalogue of Spectra of Faint Stars.*—In November 1888, the photographs required to cover the sky north of the equator were nearly finished. It was expected that in two months the observations would be completed. The telescope, which was the same as that used in the previous research, was, however, wanted for photographing the Solar Eclipse of January 1, 1889. It was accordingly sent to Willows, California, where it was mounted, and the greater portion of the remaining photographs were taken there. It was then sent to Peru, as will be described below. The few remaining photographs, including the repetition of those found on further examination to be unsatisfactory, will be taken in Peru.

3. *Detailed Study of the Spectra of the Brighter Stars.*—The 11-inch refractor with one, two, or four large prisms over its objective has been employed in this work throughout nearly every clear night, until stopped by the morning twilight; 686 photographs have been taken, most of them with an exposure of two hours. With our present photographic plates about 570 stars north of −30° are bright enough to be photographed with one prism, 170 of them with two prisms, and 87 of them with four prisms. To obtain the best possible result some of the photographs must be repeated many times. The difficulty is increased by the invariably hazy appearance of the lines in some spectra, like that of α Aquilæ, which was at first attributed to poor definition of the photograph. It is expected that the work will be completed during the next year by original or repeated photographs of 228 stars with one prism, of 64 with two, and of 12 with four. In general, stars as bright as the

[1] "Third Annual Report of the Photographic Study of Stellar Spectra conducted at the Harvard College Observatory," Edward C. Pickering, Director. (Cambridge: John Wilson and Son, University Press, 1889.)

fourth magnitude can be satisfactorily photographed with one prism, the spectra obtained being about an inch long. Fainter stars, if of a bluish colour, give sufficiently distinct images, in some cases good results being obtained with stars of the seventh magnitude. For example, fourteen stars in the Pleiades are well photographed with this apparatus. With four prisms much longer spectra are obtained and many more lines are visible. But certain differences in the character of the spectra are better shown with the smaller dispersion. Numerous photographs have been taken of the variable stars *o* Ceti and *β* Lyræ. The changes in the spectrum of the latter star seem to be undoubted, those of *o* Ceti, if any, to be slight. Various peculiarities in the spectra of individual stars have been detected. One photograph of *ζ* Ursæ Majoris shows the K line distinctly double, and others show it single. Many photographs will be required to determine the law of its variation, if this is due to changes in the star itself. Bright lines were detected in the spectrum of *φ* Persei, putting it in a class in which only two or three other stars are known to fall. In the double star *β* Cygni the two components have spectra of different types, an important consideration in the theories regarding their formation. The brighter component is of the second type, the fainter of the first.

Ordinary photographic plates are not sensitive to rays of much greater wave-length than the F line, or 486. By staining the plates with various coal-tar products the range of sensitiveness may be greatly extended. With erythrosin the spectrum extends to the wave-length 590. The sodium line D is distinctly seen to be double in the photographs of *α* Boötis and *α* Aurigæ. Various experiments were also made with cyanin, but the plates were not sufficiently sensitive to give good results. The entire length of the spectrum with four prisms, including the portion obtained by erythrosin, is about six inches and a half.

A beginning has been made of the measures of the positions of the lines in the spectrum. A scale of fortieths of an inch has been ruled on glass, and the positions of the lines read off with the aid of a magnifying-glass. Twelve of the photographs of *α* Canis Majoris have been studied in this way. The spectrum of this star is traversed by the hydrogen lines, which are strong, and by other lines which are so faint that they are only visible when the dispersion is large and the definition good. The catalogue thus formed contains about 320 lines. The average deviation of the measures of the same line on different plates is about 0·05 of a millionth of a millimetre, or 0·05 cm. on the scale of Ångström's map. If the line occurs in the solar spectrum these measures will generally identify it. In other cases the exact position must be determined by a dividing engine. If a line can be distinctly seen, its wave-length can probably be thus determined with as great accuracy as that of the position of the solar lines on the map of Ångström. In the spectrum of *α* Boötis 140 lines are visible between the D and F lines.

The classification of this large number of spectra is a matter of no little difficulty. Slight differences exist in many stars, and certain stars appear to hold an intermediate position, so as to render a rigorous division into classes impossible. On the other hand, many stars appear to have identical spectra. The first step will be to arrange the stars in groups, and then compare the best defined spectra of different groups. A minute discussion and the measurement of wave-lengths will be necessary only in the investigation of a comparatively small number of spectra.

4. *Faint Stellar Spectra.*—The 28-inch reflecting telescope constructed by Dr. Draper was assigned to this work. During the first six months of the year a careful study was made of this problem, and the difficulties encountered bore evidence of the skill of Dr. Draper in obtaining good results with this telescope. The best method of using this instrument seemed to be a modification of the form first tried by Dr. Draper,—a slit spectroscope from which the slit had been removed. The rays from the mirror were rendered parallel by a concave lens which replaced the objective of the collimator. As this lens had the same focal distance as the objective of the observing telescope, it was not necessary that either should be achromatic. After long trials with this and other forms of apparatus, a spectrum was at length obtained showing good definition. As the results were not better than those described above, and the instrument, from its size, was slow in operation, the experiments have not been carried further.

5. *Catalogue of Spectra of Bright Southern Stars.*—The 8-inch Bache telescope remained in California until February 2, 1889, and was then sent to Peru to continue research No. 1 on the southern stars. The sky from $-25°$ to the south pole will be covered, and the resulting photographs sent to Cambridge and reduced, as in the case of the northern stars. The advantages of discussing all stars from the north to the south pole according to one system are very great, and are here secured for the first time in so extensive an investigation. If no unforeseen difficulty arises, the photographs will all be completed during the next two years.

6. *Catalogue of Spectra of Faint Southern Stars.*—Research No. 2 will also be extended to the south pole simultaneously with the observations required for No. 5. It is expected that these photographs also will be completed in two years.

The Bache telescope described above has proved an extremely convenient instrument for various purposes. Besides the spectroscopic researches already mentioned, several other investigations have been undertaken with it, some of which will be found in the Memoirs of the American Academy, vol. xi. p. 179, and the Harvard Observatory Annals, vol. xviii. Nos. iv., vi., and vii. Owing to its short focal length it possesses many advantages over photographic telescopes of the usual form. With exposures of an hour and a half more stars were photographed in the Pleiades than are given in the engraving accompanying the Annual Report of the Paris Observatory for 1886, although that work was based on photographs taken by the MM. Henry with exposures of three hours and a telescope having an aperture of 13 inches. Nearly twice as many stars were photographed in this region as were visible with the 15-inch telescope of the Harvard College Observatory. The short focus of the telescope also gives it especial advantages for photographing nebulæ. Twelve new nebulæ were thus discovered in a region where but eighteen were known before. Various other investigations, such as a determination of the law of atmospheric absorption, have been undertaken with the aid of this telescope. It has been so persistently used in spectroscopic work that the other researches have been neglected, especially those in which very long exposures were required. Its removal to Peru now cuts it off for some time from such use on the northern stars. Accordingly, Mrs. Draper has procured a similar lens, which is now in the hands of the firm of Alvan Clark and Sons for retouching and mounting. Several important researches will be undertaken with this instrument. Photography is now used in so many departments of astronomy that a general investigation of the photographic brightness of the stars seems desirable. A plan has been proposed by which a single plate will contain photographs of a number of regions one degree square, but in different portions of the sky. Thus a series of standard faint stars will be photographed, which can all be measured, and reduced to the same scale. One or more photographs of the vicinity of the north pole will be taken on each plate, and thus serve to correct the results obtained on different plates. It is proposed in this way to secure a series of standards of stellar magnitude at intervals of about five degrees. A third lens of similar form, having an aperture of four inches, will be attached to the telescope, with which photographs on a smaller scale, but five degrees square, will be taken simultaneously. These photographs will cover the entire sky, and it is proposed to measure the photographic brightness of all stars of the seventh magnitude, or brighter, which are represented on them. This investigation will have a special value in connection with the photometric measures of the spectra described above. It is hoped also to photograph the entire northern sky by means of the 8-inch telescope, with exposures of an hour. Each plate covers a region nearly ten degrees square, of which the images in the central five degrees square are satisfactorily in focus. One of the regions containing standard stars will appear in the centre of each plate. By such a series of plates the photographic brightness of any stars brighter than the fifteenth magnitude can be determined on a uniform scale. The faintest stars photographed will be nearly a magnitude fainter than the limit proposed by the Astrophotographic Congress, so that all plates included in that work can be reduced to a uniform system. The advantages of such plates for studies of the distribution of the stars and other similar investigations are obvious.

From the above description it appears that the field of work of the Henry Draper Memorial, as now extended, is almost boundless. The problems to be investigated relate to the fundamental laws regulating the formation of the stellar system. Questions of such importance should be discussed on a sufficiently large scale, or the results of the discussion will soon be superseded by a repetition of the work. The liberal provision made for the Henry Draper Memorial permits the investigations to be planned on a scale which is likely to avoid such undesirable duplication of work.

GRÜNWALD'S MATHEMATICAL SPECTRUM ANALYSIS.

THE following interesting criticism of Dr. Grünwald's recent work on the mathematical spectrum analysis of various of the elements, by Joseph S. Ames, of the Johns Hopkins University, appears in the February number of the *American Chemical Journal*:—

"Dr. Anton Grünwald, Professor of Mathematics in the Technical High School at Prague, has given his theory of spectrum analysis in the following papers:—(1) 'Ueber das Wasserspectrum, das Hydrogen-, und Oxygenspectrum,' *Astronomische Nachrichten*, No. 2797, 1887, and *Phil. Mag.*, xxiv. 354, 1887; (2) 'Math. Spectralanalyse des Magnesiums und der Kohle,' *Monatshefte für Chemie*, viii. 650, *Wiener Sitz. Berichte*, 2 Abth. xcvi., 1887; *Phil. Mag.*, xxv. 343, 1888 (abstract); and (3) 'Math. Spectralanalyse des Kadmiums,' *Monatshefte für Chemie*, ix. 956.

"His aim is to discover relations between the elements by tracing connections between their spectra, and thus to arrive at simpler, if not fundamental, 'elements.' He considers the lines in the spectra of two substances, say A and B. If he finds a group of lines in the spectrum of A, which, on multiplication with a simple numerical factor, give line for line a group in the spectrum of B, he assumes that A and B have a common component. This factor, which transforms the one group into the other, is, he says, the ratio of the volumes occupied by the common constituent in unit volume of the two substances. Thus, let c be common to A and B, and let it occupy the volume $[a]$ in unit volume of A, and $[b]$ in unit volume of B; then the factor which transforms that part of the spectrum of A due to c into that of B, also due to c, is $[b]/[a]$. It is not difficult to find relations between the spectra of different substances; and, accepting Dr. Grünwald's hypothesis as to the transforming factor, we can deduce formulas for the elements. For example, in the hydrogen spectrum there are two groups of lines, $[a]$ and $[b]$, which, when multiplied respectively by $\frac{1}{32}$ and $\frac{4}{5}$, give corresponding groups in the spectrum of water, and, since in water hydrogen occupies $\frac{2}{3}$ of the volume, we have the equations

$$[a] + [b] = 1$$
$$\tfrac{1}{32}[a] + \tfrac{4}{5}[b] = \tfrac{2}{3}$$
$$\therefore [a] = \tfrac{4}{9}, \quad [b] = \tfrac{5}{9}$$

which gives hydrogen the composition ba_4. For reasons which depend upon solar physics, Grünwald calls the substance a coronium, and b helium. Further, he says that all the lines in Hasselberg's secondary spectrum of hydrogen can be changed into water-line by multiplying by $\frac{1}{2}$; which shows, according to his theory, that the modified molecule H^1 occupies in H_2O half the volume it does in the free condition. He finds that oxygen has the composition $H^1b_4(b_4c_5)_5$, where c is a new substance. In his last paper, however, Dr. Grünwald states that he has proved c to be nothing but a in a different state of compression.

"He adopts the spectrum of water, *i.e.* of the oxyhydrogen flame, as a standard, and is then able to give various criteria by means of which the primary elements a and b may be recognized. Among them are the following: If λ is the wave-length of any line produced by a as it exists in hydrogen, $\frac{32}{33}\lambda$, $\frac{3}{4}\lambda$, $\frac{5}{7}\lambda$ will each be the wave-lengths of any line of the water-spectrum, and if λ is the wave-length of any line produced by b as it exists in hydrogen, $\frac{4}{5}\lambda$ will be the wave-length of a line of the water-spectrum. Applying his criteria to magnesium, carbon, and cadmium, he finds that they are made up entirely of a and b in various states of compression. For instance, one group of lines in the cadmium spectrum is transformed into a group of b by the factor $\frac{8}{9}$, another group is identical with a group of b, and so on. But the group of lines of *shortest* wave length is transformed into a group of b by the factor $\frac{7}{8}$; and cadmium falls in the seventh row of Mendelejeff's table. Similarly, the group of lines of shortest wave-length of zinc is transformed into a group of b by the factor $\frac{8}{9}$, and zinc is in the fifth row of the table. Dr. Grünwald finds in this a general law which he verifies in the cases of Al, Si, Fe, Cu, Zn, As, Sr, Ag, Cd, In, Sn, Sb, Te, Ba, Au, Hg, Tl, Pb, and Bi. He further connects the lines of greater wave-length with the substance a; and, as in all cases so far tried all the lines can be deduced from these two substances, he is led to believe that *all the so-called elements are compounds of the primary elements a and b.*

"It is unfortunate that Dr. Grünwald has not published a complete list of the lines characteristic of a and b, for until this is done his theory cannot be accurately tested. There are two distinct questions to be answered: (1) Are there any numerical relations connecting the spectra of the elements? and if so, (2) what is the meaning of the fact? Cornu, Deslandres, and others have long since answered the first question for us, but whether Dr. Grünwald's answer to the second is correct or not depends upon the completeness with which the numerical relations hold for the *entire* spectra of the substances. It is here that Dr. Grünwald's work can be criticized.

"As noted above, the spectrum of the oxyhydrogen flame is used to test the existence of lines belonging to a and b. By far the most accurate and complete determination of this spectrum is that of Liveing and Dewar (Phil. Trans. 1888); but this does not always answer Dr. Grünwald's purposes. In the B. A. Report for 1886 there is a provisional list of lines of the water-spectrum, which he often uses, although the wave-lengths have since been corrected. Further, if other lines are necessary, they are found by halving the wave-lengths of the secondary spectrum of hydrogen. Many lines thus determined are actually present in the water-spectrum; but why are not *all* there? Dr. Grünwald says it is because the amplitude of vibrations of parts of the molecule can be so changed, owing to the presence of other substances, that the intensity may increase or diminish, or become too faint to be observed. To this argument there is absolutely no answer. In some cases, too, the average of two wave-lengths is used as a criterion of a wave-length of b which falls between them! And as a last resort, if the necessary wave-length cannot be found in the water-spectrum by any of these means, it is put down as 'new,' and is called an 'unobserved' line. As just shown, Dr. Grünwald easily explains why the strongest lines in the spectrum of an element, cadmium for example, when 'transformed' into water-lines, may be faint, and *vice versâ*. But how does he account for the fact that double lines are not transformed into double lines? This seems to me a fundamental objection. The concave-grating gives the only accurate method of determining the ultra-violet wave-lengths of the elements; and, as a consequence of not using it, most of the tables of wave-lengths so far published are not of much value. So Grünwald's error here may be great. And, besides, when we consider that in the water-spectrum as given by Liveing and Dewar, without the help of the secondary spectrum of hydrogen, there is on the average one line for every two Ångström units, it would be remarkable indeed if any law could not be verified. This is strikingly shown in the first group of the cadmium lines. Here 6742 and 6740 are two readings for the wave-lengths of the *same* line, as made by two observers; yet Grünwald finds a water-line for each of them!

"The fact that there are exact numerical relations connecting the spectra of different elements does not afford a proof of Grünwald's hypothesis; and until the above difficulties are removed the evidence is against it. But, even granting it, how do we know that a and b are not themselves compounds? In the second group of cadmium lines there are nineteen lines which can be transformed into b lines; b has many other lines; so at the most this only shows that cadmium and b have a common constituent unless, of course, the absence of the other cadmium lines is accounted for in Grünwald's own way of varying intensity.

"The lines of the spectrum of any substance, as carbon or iron, seem to fall into definite series or groups; and the wave-lengths of the lines in these groups can be expressed by formulas, as is well known. All that the fact of there being a connection between the spectra of different substances seems to show is, then, that there may be a formula common to many elements, as Kayser and Runge have recently found. And all that this means is that the molecules of those elements vibrate in general according to a similar law."

ON THE FORMATION OF MARINE BOILER INCRUSTATIONS.[1]

IN the older forms of marine boilers, sea water was almost universally employed; but with the introduction of high-pressure tubular boilers the amount of deposit was so serious, and the difficulty of removing it so great, that it became imperative to use distilled water. It is found, however, that the trouble has

[1] A Paper read at the thirtieth session of the Institution of Naval Architects, by Prof. Vivian B. Lewes, F.C.S., F.I.C., Royal Naval College, on April 11, 1889.

only been transferred from the steam boilers to the distilling apparatus, and that constant breakdowns of the latter necessitate the introduction of sea water into the boiler to eke out the supply of distilled water from the condensers.

The waters at present in use in marine boilers may be classified as—

(1) Sea water, (2) distilled water, (3) mixtures of sea water with distilled or fresh water.

In this paper the nature and causes of the deposits are studied in each of these cases.

Fresh water contains about twenty to fifty grains per gallon of dissolved solids, principally consisting of calcium carbonate, held in solution by carbonic acid present in the water, whilst sea water contains about 2300 grains per gallon, consisting principally of sodium chloride, together with magnesium salts and calcium sulphate. The wide difference in composition between fresh and sea water is also shown in the deposits formed by them. Analyses show that with fresh water the incrustation may be looked upon as consisting principally of calcium carbonate ; that with a mixture of fresh and salt water the deposit consists of nearly equal parts of calcium carbonate and calcium sulphate ; whilst the sea water gives practically calcium sulphate.

A deposit of calcium carbonate only, separates out as a soft powder, which remains suspended in the water for some time, and can fairly easily be removed from the boiler on cleaning ; whilst calcium sulphate as formed in the boiler separates out in a crystalline form, and binds the deposit into a hard mass, so hard in fact that it requires the aid of a chisel and hammer to detach it from the plates and tubes, an operation which is extremely injurious, and tends to shorten the life of the boiler.

Calcium sulphate is much more soluble in a saline solution such as sea water than it is in fresh water, but its solubility rapidly decreases (1) on concentration of the saline solution, and (2) with increase of temperature and pressure.

Sea water having a density of 1·027 was evaporated, and analyses made at different densities with the following results :—

Saline Constituents per Cent.

	Density ... 1·029	1·05	1·09	1·225
Sodic chloride	2·6521	4·4201	7·9563	23·8689
Calcic sulphate ...	0·1305	0·2175	0·3915	none
Calcic carbonate ...	0·0103	0·0171	none	none
Magnesic carbonate ...	0·0065	0·0032	none	none
Magnesic chloride ...	0·2320	0·3865	0·6960	2·0880
Magnesic sulphate ...	0·1890	0·3150	0·5670	1·7010

So that on concentrating sea water at ordinary atmospheric pressure, three distinct stages may be traced :—

(1) Deposition of basic magnesic carbonate ;

(2) Deposition of calcic carbonate with remaining traces of the basic magnesic carbonate and hydrate ; and, finally,

(3) Deposition of the calcic sulphate.

If the sea water be heated and concentrated above a density of 1·225, the salt commences to crystallize out.

These experiments show that if sea water be boiled merely under atmospheric conditions, it would be quite possible, by taking care that its density does not rise above a certain point (1·09) to prevent the deposition of the calcium sulphate ; but any such regulation of density is rendered abortive by the fact that pressure and consequent raising of the boiling-point acts upon the calcium sulphate in solution in exactly the same way as concentration, as it is found that this substance is perfectly insoluble in either sea or fresh water at a temperature of 150° C. In the present high-pressure boilers, even if the sea water be mixed with a hundred times its volume of distilled water, so as to reduce its density very low, deposition of calcium sulphate still occurs.

Analyses of several specimens of deposits from boilers where sea water was used, showed that in all cases there were two distinct layers—(1) a hard crystalline deposit on the sides of the tubes, consisting of nearly pure calcium sulphate in the form of "anhydrite" ; (2) a softer portion resembling alabaster in the interior, consisting of calcium sulphate, with about 6 per cent. of magnesic hydrate.

The presence of magnesic hydrate in boiler deposits is supposed to be due to the mutual decomposition of water and magnesic chloride, later experiments have shown, however, that when magnesic chloride and calcium carbonate mutually react upon each other, soluble calcium chloride and magnesium hydrate are formed ; this explains why calcium carbonate is never found, except in very small quantities in marine boiler deposits.

When distilled water only is used, a slight coating is formed, practically consisting only of organic matter, whilst if at any time through a break-down in the distilling apparatus sea water is mixed with the distilled water, a thin and very hard scale of calcic sulphate is formed. An incrustation of this character gave on analysis :—

Calcic sulphate	90·84
Magnesic hydrate	0·75
Sodic chloride	1·41
Silica	0·85
Copper carbonate	1·11
Oxides of iron and alumina	0·24
Organic matter	2·96
Moisture	1·84
	100·00

This scale is of great interest from the presence in it of the carbonate of copper. It is well known that distilled water has a far greater solvent effect upon metals than a water containing salts in solution, and it is quite conceivable that the distilled water from the surface condensers attacks the brass and copper tubes and fittings, and deposits the copper on the tubes of the boiler, although in only small quantities ; and it is interesting to note that the green spots due to the presence of the copper are all on the under side of the scale—that is, in contact with the metal of the boiler tubes, showing that in all probability it had been deposited, as suggested, from the water in the boiler, and in contact with the iron would set up local galvanic action and tend to produce pitting.

The importance of preventing boiler incrustation, and thereby saving the enormous waste of fuel and injury which it entails, has not been without influence on the minds of inventors, and almost every conceivable substance, from potato-parings to complex chemical reagents, have from time to time been patented for this purpose, but have failed more or less for marine boilers, because either they have had an injurious effect upon the metal of the plates, or else have produced an enormous bulk of loose deposit, which, although easily cleaned out if the various parts of the boiler were accessible, and if it were only being used intermittently, yet in a marine boiler continuously working, rapidly chokes the portions between the tubes.

For these reasons, no treatment of the sea water in the boilers themselves is practically possible, and with high-pressure tubular marine boilers the water must be either condenser water, made up to the required bulk with distilled water, as is at present done, or else the condenser water must be augmented by sea water specially prepared for the purpose in a separate apparatus before being supplied to the boilers.

If the engines of a vessel are in good condition, she will approximately require 1 ton of water per 1000 horse power per twenty-four hours, to make up the volume of the condenser water to the amount required for the boilers, so that, even supposing the engines not to be in good order, and considerable waste to take place, 10 tons per diem would be an outside allowance for even very large vessels. To obtain this amount of treated sea water the author proposes an arrangement, full details and diagram being given in the original paper.

The sea water, containing 40 pounds of soda crystals to the ton is heated up under pressure in a separate apparatus by passing through the solution superheated steam. Under these conditions the precipitated mixture of calcium and magnesium carbonates becomes very dense and settles very quickly. The water is then forced through filtering frames into the hot well of the boiler and is then ready for use. The whole process is effective and rapid, and simple arrangements are made for flushing out the apparatus, after each batch of water.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The courses of science lectures this term are as numerous as usual, but present few noteworthy features. Mr. Gardiner gives a general course of Botany, while Mr. Darwin is conducting the course of Elementary Biology (Plants), the lectures being given in the Archæological Museum Lecture Room. Prof. Macalister is lecturing on the History of Human

Anatomy, a subject on which a brief volume from his pen would be very acceptable. Prof. Foster's course is on the Physiology of the Senses this term.

Among the numerous courses of demonstrations in the Cavendish Laboratory we may note those of Mr. Wilberforce on Dynamo-Electric Machines (Alternating Current Generators and Transformers).

Two lectures will be given in the Literary Schools on June 4, and June 8 at 2.15 p.m., by Dr. Francis Warner, on the Study of Mental Action and the Classification of Pupils according to their Brain Power.

LONDON.—The following appointments of Examiners in various branches of Science in the University of London were made on Wednesday, April 24:—Prof. Hill and Dr. Larmor as Examiners in Mathematics and Natural Philosophy; Prof. Fitz-Gerald and Mr. Glazebrook as Examiners in Experimental Philosophy; Dr. Pole and Sir John Stainer as Examiners in Music; Prof. Tilden as Examiner in Chemistry; *Prof. H. E. Armstrong, F.R.S., as Examiner in Chemistry; Prof. Bower and Prof. Ward as Examiners in Botany and Vegetable Physiology; Mr. Sedgwick as Examiner in Comparative Anatomy and Zoology; *Sydney J. Hickson as Examiner in Comparative Anatomy and Zoology; Prof. Boyd Dawkins as Examiner in Geology and Palæontology; *Prof. Charles Lapworth, F.R.S., as Examiner in Geology and Palæontology. The asterisks denote new appointments. The gentlemen to whose names no asterisks are prefixed held the same appointments last year.

SCIENTIFIC SERIALS.

American Journal of Science, April.—Contributions to meteorology, by Elias Loomis. In this paper, which was read before the National Academy of Sciences, November 14, 1888, the chief subjects discussed are the relations of rain areas to areas of high and low pressure. From these studies it appears generally that no great barometric depression with steep gradients ever occurs without considerable rain; that in great rain-storms the barometric pressure usually diminishes while the rainfall increases; that the greatest depression of the barometer generally occurs about twelve hours after the greatest rainfall; that a great rainfall is favourable to a rapid progress of the centre of least pressure. It also appears that in Great Britain the amount of rain with a falling barometer is twice that with a rising barometer; but this ratio diminishes rapidly eastwards, the precipitation in Central Europe being greater when the barometer is rising than when it is falling.—The sensitive flame as a means of research, by W. Le Conte Stevens. These experiments, which take as their starting-point Lord Rayleigh's memoir on "Diffraction of Sound" (Proceedings of the R. Institution, January 20, 1888), tend to show that the sensitive flame is not applicable for purposes of exact measurement, though it is much more nearly so than has been generally supposed. Without its aid it would have been impossible to establish the important analogies here shown to exist between light and sound.—The Denver Tertiary formation, by Whitman Cross. In this paper a succinct account is given of the newly determined Tertiary formation about the Denver district, Colorado, which had hitherto been assigned to the Laramie Cretaceous. Although of limited geographical extent, this formation possesses features of special importance in several respects. The vertebrate remains here occurring present some very remarkable associations, which appear to be in direct conflict with all past observations.—Events in North American Cretaceous history illustrated in the Arkansas-Texas division of the south-western region of the United States, by Robert T. Hill. Here are embodied the results of the author's investigation of the stratigraphic and palæontological conditions in the northern and eastern termination of the Texas Cretaceous, which are brought into relation with the corresponding formations in the Gulf and Western States.—The distribution of phosphorus in the Luddington Mine, Iron Mountain, Michigan, by David H. Browne. The results are here given of some 3000 analyses of ore from the Luddington Mine made during the last three years by the author while acting as chemist to the Lumberman Mining Company. Although no generalizations are attempted, these analyses tend to throw much light on one of the most difficult problems in the chemistry of iron ore—the distribution, throughout the vein, of Bessemer ore, and its relation to the formation of the deposit.—Papers were contributed by C. S. Hastings, on a general method for determining the secondary chromatic aberration for a double telescope objective, with a description of a telescope sensibly free from this defect; by G. Baur, on Palæohatteria, Credner, and the Proganosauria; and by O. C. Marsh, on some new American Dinosauria, with a comparison of the principal forms of the Dinosauria of Europe and America.

Bulletin de l'Académie Royale de Belgique, March.—On the discovery of some fossil remains of mammals anterior to the diluvium at Ixelles near Brussels, by Michael Mourlon. These deposits, brought to light in August 1888, were all found at a lower level than that of the rolled Quaternary gravels, and at some points were overlain by several beds of undisturbed shingle. They include remains of the cave bear, of *Elephas antiquus*, of *Bison priscus*, *Bos primigenius*, the hare, *Equus caballus*, and a smaller equine species here described under the name of *Equus intermedius*, altogether forty four individuals, representing five known and four not yet determined species, and presenting a general resemblance to the mammalian fauna of the English forest-bed.—On the physical properties of the free surface layer of a fluid, and on the contact layer of a fluid and a solid, by G. Van der Mensbrugghe. The experiments here described lead to results opposed to the capillary theories of Laplace and Poisson; they further show that the theory of Gauss is intimately associated with the surface tension of fluids, one leading inevitably to the other, and confirming the author's previous conclusion that the demonstrated existence of tension justifies the theory of Gauss.—Note on a theory of the secular variation of terrestrial magnetism deduced from experimental data, by Ch. Lagrange. Several arguments are advanced in support of the author's new hypothesis that the secular magnetism of the earth is due to a magnetic potential interior and not exterior to the surface of the globe. The solid globe itself is thus regarded as a magnet, or a solenoid—that is, as a magnetic body properly so called, or as a conductor traversed by circular currents.—A paper is contributed by P. De Heen on the determination of the theoretic formula expressing the variations of volume experienced by mercury with the changes of temperature.

Rendiconti del Reale Istituto Lombardo, March 28.—Influence of the digestive juices on the virus of tetanus, by Prof. G. Sormani. A series of experiments are described, which the author has carried out on rabbits, guinea-pigs, rats, and dogs, from which are drawn the following conclusions: (1) the flesh of animals dying of tetanus may be consumed with impunity; (2) the bacillus of tetanus swallowed by carnivorous and herbivorous animals passes through the system without causing death or any special disturbance; (3) the gastric juices of herbivorous animals neither kill, nor diminish the virulence of, the bacillus; (4) an animal may with impunity swallow a quantity of the virus ten thousand times more than would suffice to kill if introduced by hypodermic inoculation; (5) the facts here determined throw some doubt on the accepted theory that the effects of tetanus are due to the absorption of poisonous alkaloids derived from the bacillus.—G. Somigliana contributes a paper on differential parameters, explaining a process by which they may be formed, and demonstrating the invariability of those of the first order. Certain relations, either new or more general than those hitherto studied, are also established between the parameters of the first and second orders.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 4.—"The Ferment Action of Bacteria." By T. Lauder Brunton, M.D., F.R.S., and A. Macfadyen, M.D., B.Sc.

The chief objects of this research were, (A) to discover whether microbes act on the soil upon which they grow by means of a ferment; and (B) whether such a ferment can be isolated, and its action demonstrated on albuminoid gelatine and carbohydrates, apart from the microbes which produce it, in the same way that the ferments of the stomach and pancreas can be obtained apart from the cells by which they were originally secreted.

The microbes used were Koch's spirillum, Finkler's spirillum, a putrefactive micrococcus, scurf bacillus, and Welford milk bacillus (Klein).

The results of the inquiry were as follows:—

(1) The bacteria which liquefy gelatine do so by means of an enzyme.

(2) This enzyme can be isolated, and its peptonizing action demonstrated, apart from the microbes which produce it.

(3) The most active enzyme is that formed in meat broth.

(4) Acidity hinders, alkalinity favours, its action.

(5) The bacteria which form a peptonizing enzyme on proteid soil can also produce a diastatic enzyme on carbohydrate soil.

(6) The action of the diastatic enzyme can be demonstrated apart from the microbes which produce it.

(7) The diastatic enzyme has no effect on gelatine, and *vice versâ*.

(8) The microbes, for purposes of nutrition, can form a ferment adapted to the soil in which they grow.

(9) The putrefactive micrococcus gave negative results.

Linnean Society, April 18.—Mr. Carruthers, F.R.S., President, in the chair.—In view of the approaching anniversary meeting, the following were appointed auditors:—For the Council, Dr. John Anderson and Mr. Jenner Weir; for the Fellows, Mr. T. Christy and Mr. D. Morris.—The President called attention to a valuable donation of books on fishes, including the celebrated work of Bloch, recently presented to the Society's library by Mr. Francis Day, who, he regretted to say, was lying seriously ill at Cheltenham; upon which a cordial vote of sympathy and thanks was unanimously accorded.—Mr. J. R. Jackson, Curator of the Museum, Kew Gardens, exhibited specimens illustrating the mode of collecting at Ichang, China, the varnish obtained from *Rhus vermicifera*, so largely used by the Chinese and Japanese for lacquering. He also exhibited some Chinese candles made from varnish seed-oil.—On behalf of Mr. Henry Hutton, of Kimberley, some photographs were exhibited, showing the singular parasitic growth of *Cuscuta appendiculata* on *Nicotiana glauca*.—Dr. Cogswell exhibited specimens of vegetables belonging to four different families of plants, to illustrate the symmetrical development of rootlets.—Prof. Martin Duncan exhibited, under the microscope, and made remarks upon, the *sphæridia* of an Echinoderm.—Dr. Masters gave a summary of a paper on the comparative morphology and life-history of the Coniferæ, a review of the general morphology of the order based upon the comparative examination of living specimens in various stages of development. These observations, made in various public and private "pineta," supplemented by an examination of herbarium specimens, demonstrated the utility of gardens in aid of botanical research. The mode of germination, the polymorphic foliage, its isolation or "concrescence," its internal structure, the arrangements of the buds, the direction and movements of the shoots, were all discussed. In reference to the male and female flowers, the author described their true nature, tracing them from their simplest to their most complex or most highly differentiated condition; and showed that, so far as known, the histological structure and development were essentially the same throughout the order. Various special forms, such as the needles of *Pinus*, the phylloid shoots of *Sciadopitys*, and the seed-scales of *Abietineæ*, were described, and their significance pointed out. The phenomenon of enation with the correlative inversion of the fibro-vascular bundles in such outgrowths was considered in relation to the light it throws upon certain contested points in the morphology of the order; the chief teratological appearances noted in the order were detailed, and their significance discussed; the various modifications were shown to be purely hereditary or partly adaptive, and dependent on permanent or intermittent arrest, excess, or perversion of growth and development, and to various correlative changes; lastly, the polymorphic forms of the so-called genus *Retinospora*, suggested that in studying them we might be watching the development and fixation of new specific types.

Chemical Society, April 4.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read:—The rate of dissolution of metals in acids, by Mr. V. H. Veley. The dissolution of copper in a solution of potassium bichromate acidified with sulphuric acid was investigated as affording a case in which no gas was evolved as such. The copper was employed in the form of metallic spheres which by various mechanical devices were rolled about continuously and regularly in the acid liquid, and the products of the changes continuously removed from the immediate neighbourhood of the metal. The author finds (1) that if the temperature be varied between 21° and 41° in an arithmetical proportion the amount of chemical action varies in a geometrical proportion; (2) that if the amount of sulphuric acid be varied in an arithmetical proportion between the limits of 41·3 and 23·5 grammes per litre, the amount of change also varies in an arithmetical proportion; and (3) that the amount of change is at first considerably increased by increase of proportion of potassium bichromate, but the effect afterwards gradually diminishes to *nil*, at which point the bichromate can be considered to be so much inert material: the amounts used varied from 22·1 to 66·3 grammes per litre.—Note on the interaction of metals and acids, by Prof. H. E. Armstrong. When a metal forming an element in a voltaic couple is dissolved, the rate of dissolution is in accordance with Ohm's law, C = E/R: and this should apply also to the case in which a metal is dissolved without any precaution being taken to arrange it as an element of a couple, as the action is conditioned by the formation of, and takes place within, "local circuits." The changes attending the dissolution of metals may, therefore, in a certain sense be said to be purely electrical in the first instance; yet within recent years it has been argued by various chemists that the phenomena are only in part electrical and in part chemical—whatever this may mean. The author discussed the various phases of such changes, and criticized the conclusions arrived at by Spring and Aubel and others. Referring to Mr. Veley's experiments Prof. Armstrong expressed the opinion that the results were in no way commensurate with the labour expended in obtaining them: although by introducing bichromate polarization by hydrogen had been prevented, its use had introduced complications which made the analysis of the results impossible; in fact the information likely to be obtained from such experiments was not of the kind required in the present state of chemical science. Thus the proof obtained that a copper sphere dissolved uniformly in a mixture of sulphuric acid and bichromate was but a proof of the efficiency of the stirring apparatus: such would necessarily be the case, as the values of E and R remained almost unchanged throughout the experiment owing to the relatively small proportion of the agents used up. In the course of his reply Mr. Veley mentioned that he had had occasion to verify Dr. Russell's observation that silver is not dissolved by nitric acid free from nitrous acid, to which reference had been made, and stated that in experiments with copper and nitric acid he had observed that the action took place at first more slowly, and only attained a maximum rate when a certain small amount of nitrate was formed. Prof. Armstrong remarked that this was a really important observation, proving that the dissolution of copper in nitric acid was dependent on the presence of a third substance—perhaps cupric nitrate.—A zinc mineral from a blast furnace, by Mr. J. T. Cundall.

Zoological Society, April 29.—Sixtieth Anniversary Meeting.—Prof. Flower, C.B., F.R.S., President, in the chair.—In the Report of the Council on the proceedings of the Society during the year 1888, it was stated that the number of Fellows on January 1, 1889, was 3076, showing a decrease of twenty-eight as compared with the corresponding period in 1888. The total receipts for 1888 had amounted to £24,025 10*s*. 8*d*., showing an increase of £922 15*s*. 2*d*., as compared with the previous year. The receipts from admissions to the Gardens had risen from £12,138 to £13,284. The ordinary expenditure for 1888 had been £21,439 16*s*. 4*d*., which was £2436 less than the corresponding amount for 1887. Besides this, an extraordinary expenditure of £700 had been incurred, which had brought up the total expenditure for the year to £22,139. The sum of £1000 had been employed in repayment of a temporary loan from the bankers, and a further sum of £1000 had been devoted to the diminution by that amount of the debt on the Society's freehold premises, which now stood at £7020. After deducting these payments from the income of 1888, and adding to it the balance of £1158, brought over from the previous year, a balance of £1043 was carried forward for the benefit of the present year. The usual scientific meetings had been held during the session of 1888, and a large number of valuable communications had been received upon every branch of zoology. These had been published in the annual volume of Proceedings for 1888, which contained 717 pages, illustrated by thirty-two plates. Besides this, Part 7 of the twelfth volume of the Society's quarto Transactions, illustrated by eight plates, had been issued. The volume of the "Zoological Record" for 1888, containing a summary of the work done by British and foreign zoologists in 1887, had been issued early in the present year. It had been edited by Mr. F. E. Beddard, the Prosector to the Society. An important event in connection with the Library during the past year had been the receipt from the

executors of the late Madame Cornély, widow of the late M. J. M. Cornély, an old and valued corresponding member of the Society, of a valuable library of zoological books. The Cornély Library consisted of about 840 volumes, of which 256 were new to the Society's Library, and many of these were rare and difficult of acquisition. In the Gardens in Regent's Park, the work during the past year had been entirely confined to repairs and renewals, which, however, had kept the staff of workmen busily engaged. The visitors to the Gardens during the year 1888 had been altogether 608,402, the corresponding number in 1887 having been 562,898. The number of animals in the Society's collection on December 31 last was 2290, of which 666 were Mammals, 1280 Birds, and 314 Reptiles. Amongst the additions during the past year nine were specially commented upon as of remarkable interest, and in most cases representing species new to the Society's collection. About thirty-one species of Mammals, seventeen of Birds, and two of Reptiles had bred in the Society's Gardens during the summer of 1888.—The Report having been adopted, the meeting proceeded to elect the new members of Council and the officers for the ensuing year. The usual ballot having been taken, it was announced that Lieut.-Colonel the Lord Abinger, C.B., Mr. Henry A. Brassey, Mr. Henry E. Dresser, Lieut.-General Sir H. B. Lumsden, K.C.S.I., and the Lord Arthur Russell, had been elected into the Council in place of the retiring members; also that Mr. Walter Morrison, M.P., elected into the Council since the last anniversary, had been re-elected in place of the late Surgeon-General L. C. Stewart (deceased); and that Prof. Flower, C.B., F.R.S., had been re-elected President; Mr. Charles Drummond, Treasurer; and Mr. Philip Lutley Sclater, F.R.S., Secretary to the Society for the ensuing year.

PARIS.

Academy of Sciences, April 15.—M. Des Cloizeaux, President, in the chair.—Researches on the thionic series, by M. Berthelot. The author describes a new method recently discovered by him, by means of which he has succeeded in measuring the heat of formation of nearly all the terms in the thionic series, such as the dithionic, trithionic, tetrathionic, and pentathionic acids. The method consists in oxidizing the salts of the thionic acids, previously dissolved, by means of bromine dissolved either in water, or, better, in bromide of potassium. For acids formed by the union of the same element combined in multiple proportions of oxygen there is in most cases a certain proportion between the liberated heat and the combined oxygen, a law already indicated by Dulong.—Experiments on putrefaction and on the formation of manures, by M. J. Reiset. Detailed descriptions are given of the critical experiments briefly referred to by the author in his recent communication on this subject. He also deals with a serious objection that has been raised against his general conclusion regarding the liberation of nitrogen during the process of putrefaction.—Movement of cyclonic storms in the various regions of the globe, by M. H. Faye. A general survey is given of the salient features of these phenomena in the North Atlantic, the Bay of Bengal, the Arabian Sea, the Indian Ocean, the China Sea, and Japan waters—that is, in the regions where they have been most carefully studied. The author insists on the essential identity of all their main characteristics; everywhere the same rapid trajectory from the equator towards one or other of the poles; the same manner of gyration narrowing towards the base round about vertical axes; the same progressive expansion frequently developing phenomena of varied segmentation far from the equator; the same independence of local climatic conditions pointing to their common origin in the upper atmospheric regions, and showing that these violent disturbances do not belong exclusively to the science of meteorology, but are the grandest terrestrial manifestations of the mechanics of fluids, acting in conformity with the simple theory already, on several occasions, announced by the author.—Observations of Barnard's new comet, March 31, made at the Observatory of Algiers with the 0·50 m. telescope for the period April 4-10, by MM. Trépied, Rambaud, and Renaux.—On the specific heat of sea water at different degrees of dilution and concentration, by MM. Thoulet and Chevallier. The measurement of the specific heat has been executed according to M. Berthelot's method with water taken on the Fécamp coast, sometimes pure, sometimes with distilled water added, and sometimes concentrated by evaporation, the determination both of the densities and of the specific heats being made at the temperature of 17°·5 C. The calculations here worked out explain the enormous influence exercised by the sea in regulating the climates of the globe.—On the intensity of telephonic effects, by M. E. Mercadier. In continuation of his previous note (*Comptes rendus*, cviii. p. 737) the author here describes his further experiments with aluminium and copper diaphragms. The effects produced with these are found, under like conditions, to be far less intense than with iron diaphragms, the chief cause of the difference being the very slight specific magnetism of the former as compared with the latter. On the other hand, the *quality* of the effects produced by the aluminium and copper diaphragms is very remarkable, as they give the *timbre* of sounds and of articulate speech far better than iron.—Researches on some new metallic sulphides, by MM. Arm. Gautier and L. Hallopeau. In continuation of the already described studies (*Comptes rendus*, cvii. p. 911) on the action of carbon-di sulphide on the argillaceous earths, the authors have been led to examine its action on various metals at a red heat. The sulphides thus produced include those of iron, manganese, and the silicate of manganese described in this paper, and of nickel, chromium, lead, and aluminium, which are reserved for a future communication.—On the heat of combustion of some organic substances, by M. Ossipoff. The author has undertaken a series of experiments for the purpose of determining the heats of combustion of certain organic bodies not yet studied from the thermic standpoint. He has already completed the study of cinnamic, atropic, and terebic acids, all of which are described in the present paper.—Bacteriological researches on the disinfection of hospitals, dwellings, &c., by gaseous substances, and especially by sulphurous acid, by MM. H. Dubief and I. Bruhl. From these experiments it appears that gaseous sulphurous acid has a destructive effect on germs contained in the air, especially when saturated by the vapour of water; that it acts mainly on the germs of bacteria, and that when employed in the pure state for a prolonged period it may prove fatal to germs even in the dry state.

April 23.—M. Des Cloizeaux, President, in the chair.—On the theory of the capture of periodical comets, by M. F. Tisserand. The object of this paper is to supply a rigorous proof of the theory, based on Laplace's study of Lexell's comet, that the influence of Jupiter, acting on a comet with parabolical orbit, may under certain conditions transform its course to an elliptical orbit analogous to those of the group of periodical comets. Some of the formulas here worked out agree very well for two of Tempel's comets and for that of Vico; but full details are reserved for the next issue of the *Bulletin Astronomique*.—Memoir on the ravages caused to agriculture by the cockchafer and its larva, by M. J. Reiset. The results are described of the measures that have been taken in France for the destruction of this pest since the year 1866. A detailed account is appended of its remarkable biological transformations, and instances given of its surprising vitality, surviving complete immersion in water for over four days, and when buried to a depth of 0·40 metre in the earth remaining in a state of suspended animation for 150 days.—Observations of Barnard's new comet, March 31, made at the Observatory of Paris (equatorial of the east tower), on April 19, by Mdlle. D. Klumpke; at the same Observatory (equatorial of the west tower), on April 18-19, by M. G. Bigourdan; and at the Observatory of Bordeaux with the 38 cm. equatorial, on April 20, by M. G. Rayet. During these observations the comet generally presented the appearance of a slight nebula with a nucleus of the fourteenth magnitude.—On magnetic rotatory polarization, by M. Vaschy. It is shown that M. Potier's recent hypothesis (*Comptes rendus*, March 11, 1889) on the action of the ether on ponderable matter offers a remarkably simple explanation of this phenomenon. On the other hand, it lends no support to Ampère's theory regarding molecular currents.—On the initial mode of deformation of the ellipsoidal crust of the earth, by M. A. Romieux. M. Daubrée's well-known experiments serve as the basis of a theory of the original crumpling and folding of the terrestrial crust, which is here worked out with illustrations. M. Romieux considers that, although now far removed from that initial deformation, the globe still retains many traces of its effects as here described. Thus, the Pacific Ocean, a vast and very ancient equatorial basin, acting in opposition to a continental mass with its more recent depression of the Central Mediterranean, is supposed to have impelled by successive spasmodic pressures three or four zones of folding against the resisting mass of the North Pole.—On the combinations of ruthenium with nitric oxide, by M. A. Joly. Continuing his investigations on this subject (see *Comptes rendus*, cvii. p. 994), the author here adds a considerable number to the

compounds of ruthenium with nitric oxide. They comprise a compound of nitric oxide with the trichloride, $RuCl_3(NO) + H_2O$, and with the sesquioxide, $Ru_2O_3(NO)_2 + 2H_2O$, both remarkably stable bodies, resisting the action of water, of bases and acids, and decomposing only at a temperature above 300° C. It is suggested that analogous nitrous combinations might be formed with rhodium, and with osmium. In a future communication M. Joly proposes to show that the substances described by Fritsche and Struve, under the names of osmanosmic or osmiamic acid and of osmiates, have a constitution similar to that of these compounds of ruthenium. — Researches on the richness of wheat in gluten, by MM. E. Gatellier and L. L'Hote. A series of experiments are described by which the same wheat (white Victoria) is made to yield increasing proportions of gluten. The increase largely depends on the rotation of crops and on the proportion of nitrogen to phosphoric acid contained in the manures.—Papers were contributed by M. J. Janssen and Colonel Gouraud on Mr. Edison's improved telephone, full details of which have already appeared in the English scientific journals. The proceedings concluded with the following phonographic message sent by the President to Mr. Edison: "M. le Président et les Membres de l'Académie des Sciences adressent leurs félicitations à M. Edison pour les nouveaux perfectionnements qu'il a apportés à son phonographe, et espèrent le voir bientôt à Paris, à l'occasion de l'Exposition Universelle."

BERLIN.

Physiological Society, April 12.—Prof. du Bois-Reymond, President, in the chair.—Prof. Fritsch gave a brief account of the results he has obtained from the examination of the electrical organ of Torpedo which he has been carrying on for several years. Both Wagner and Remak had correctly made out that each plate consists of two layers, one dorsal and one ventral; that the nerves are attached to the plate from the under side, and are distributed in branches over it; and that the under surface of the plate is dotted. Very little further information as to the structure of this organ has resulted from the many investigations subsequent to those of the above-named observers. Prof. Fritsch then explained and set aside the views of the best-known observers, and summed up his own conclusions as follows. The lowest or marginal layer is composed of a layer, which is here and there discontinuous, of globules, which refract light very strongly; between these the terminal fibres of the nerves make their way into the plate. The pallisade-layer, which some previous observers had described, has an existence in the form of a number of extremely fine filaments, which stand at right angles to the plate, but inasmuch as they are so fine as to be scarcely visible, nothing can for certain be made out as to their nature. Passing further in a ventral direction, globular structures are found in the lower plate, seated upon fibres which branch dichotomously; these may perhaps be bulbous nerve-endings. Large nuclei lie between the ventral and dorsal layers. The dorsal or muscular layer contains extremely fine granules, arranged in rows at right angles to the surface. The above results were obtained by the application of the modified treatment with nitric acid. A series of photographs and drawings was exhibited in explanation of that which was described, and several preparations were shown under the microscope.—Prof. Preyer spoke on reflexes in the embryo. His researches extended over many classes of animals. As representing Mammals, guinea-pigs were chiefly used; and for reptiles, snakes; while in addition the embryos of fishes, frogs, mollusks, and other lower animals were also employed. But of all animals birds are most suitable for embryological observations, inasmuch as, with due precautions, the development of one and the same individual can be followed for a considerable time. Birds' eggs can be incubated in a warm chamber, and by removing a portion of the shell and replacing it by an unbroken piece from another egg, it becomes possible to follow the daily development of the chick and to experiment upon it. As early as the ninetieth hour of incubation, spontaneous "impulsive" movements may be observed, taking place apparently without any external stimulus as a cause, and at a time when no muscles or nerves have as yet been developed. After the occurrence of these spontaneous movements, and at the earliest on the fifth day of incubation, movements are observed to result from the application of mechanical, chemical, and electrical stimuli. In order to observe these the eggs must be allowed to cool down until all spontaneous movements have ceased. From the tenth to the thirteenth day more complicated and reflex actions occur on the application of stimuli, as, for instance, movements of the eyelids, beak, and limbs; and if the stimuli are strong, reflex respiratory movements. These reflexes make their appearance before any ganglia have become differentiated. Prof. Preyer considered himself justified in concluding from this that ganglia are not essential for the liberation of reflex actions. He intends, on some future occasion, to give a more detailed account of these experiments, and of the conclusions which may be drawn from them. In the discussion which ensued the conclusions of the speaker were contested from many sides.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Year Book of the Scientific and Learned Societies of Great Britain and Ireland, sixth annual issue (Griffin).—Subjects of Social Welfare: Sir Lyon Playfair (Cassell).—Biologie der Pflanzen, mit Einem Anhang: Die Historische Entwicklung der Botanik: Dr. J. Wiesner (Wien, Hölder).—The Theory of the Continuous Girder: M. A. Howe (New York).—A Vertebrate Fauna of the Outer Hebrides: J. A. Harvie-Brown and T. E. Buckley (Edinburgh, Douglas).—*Challenger* Report, vol. xxx. Zoology, Text and Plates (Eyre and Spottiswoode).—Animal Locomotion, 1872-85, Plates: E. Muybridge (Philadelphia).—The Metallurgy of Gold, 2nd edition: M. Eissler (Lockwood).—Himmel und Erde, Heft 8 (Berlin).—Journal of the Royal Agricultural Society of England, April (Murray).

CONTENTS.