THURSDAY, FEBRUARY 21, 1889.

THE ILLUSTRATED OPTICAL MANUAL.

The Illustrated Optical Manual. By Sir T. Longmore, C.B., F.R.C.S. Fourth Edition. Pp. 239. (London: Longmans, Green, and Co., 1888.)

IN the present edition this manual, which was originally intended for army medical officers, has been considerably enlarged, with a view to its suitability as a text-book for civil as well as for military surgeons. Civil surgeons, however, are abundantly supplied with excellent works on ophthalmology; and for this reason (to say nothing of the fragmentary nature of Sir T. Longmore's Manual) we scarcely think that it will ever enjoy any large vogue amongst that class. The author treats of the detection and correction of refractive errors, and of optical defects generally: surely it would have been better to produce at once a complete manual of ophthalmology than to treat the subject in this piecemeal fashion. For how can any military surgeon be certain of his diagnosis in a case unless he has a thorough knowledge, not only of errors of refraction, but of eye diseases as well?

The opening chapter, on optical principles, is very good; the description of refraction, &c., being well and clearly done. Speaking of the composition of spectacle lenses, the author points out that the only real advantage possessed by quartz lenses ("pebbles") over ordinary crown glass ones is that they are harder, and, therefore, are not so easily scratched. By experiment, he has ascertained, contrary to the common supposition, that there is no difference in weight between pebbles and crown glass lenses of corresponding powers. The tourmaline forceps, for determining whether a pebble lens is, or (as is often the case) is not, cut exactly perpendicular to the axis of the crystal, is figured and explained.

We notice some peculiar statements in the chapters on myopia, hypermetropia, and astigmatism. For example, it is stated that the myopic eye "usually presents some peculiar characters indicative of its condition. It is prominent, or even appears to protrude; the pupil is usually contracted." At times, no doubt, cases of high myopia are seen in which the eyes do appear to be unduly prominent; but it is a sign of no value, and one which is more often absent than present. The pupil, if it shows any change at all, tends, in myopes, not to contraction, but to dilatation. In estimating refraction by the direct method, the examiner is recommended to place himself 18 inches or more from the patient's eye. This is an extraordinary statement, our impression heretofore being that it was impossible to be too close to the patient's eye. In examining the fundus oculi by the direct method of ophthalmoscopic examination, the examiner, it is stated, will have little or no tendency to bring his accommodation into play. This, again, is quite contrary to the experience of most persons; in fact, one of the greatest troubles experienced by tyros is that they almost invariably call their accommodation into play when it should be quiescent, and many adepts are unable, even after years of practice, completely to relax their ciliary muscles. The refraction, as tested by the direct method, is enjoined to be taken at the optic disk. Although this is the usual plan, a caution might well have been given that the refraction at the blind spot (optic disk) and at the yellow spot (the point of the most accurate vision) may differ appreciably. Again, in practising retinoscopy, it is recommended that the patient's eye be turned inwards. By this means, doubtless, a more easily seen reflex is obtainable with a small pupil, but this great drawback attaches to the method, that the refraction of some part of the fundus, other than the yellow spot, is estimated.

Sir Thomas Longmore gives currency to the views of his colleague, Dr. Macdonald, on the subject of normal astigmatism. Briefly, they are as follows. Every eye has a greater curvature in its vertical than in its horizontal meridian, but the difference in curvature is so slight that it does not interfere with visual acuteness. The meridian of greater curvature is not exactly vertical, but intersects the vertical meridian at an angle of about 15°. When a vertical line is held within the near point of an eye it is blurred; but when the left eye alone is used, the left side of the line is less blurred than the right side; when the right eye alone is used, the right side of the line is seen more distinctly than its left side. The effect of this is that a line held within the near point is seen more distinctly when both eyes are used than when either eye by itself is used. Hence, in this view, normal astigmatism becomes an important aid to the perfection of binocular vision of near objects.

The regulations as to the visual examination of recruits are given in detail. The vision of regular army recruits is ascertained by their ability to count test-dots, one-fifth of an inch in diameter, held 10 feet from the eye: this is equivalent to a bull's eye target, 3 feet in diameter, at 600 yards. Sir Thomas remarks that the standard is very low, since an eye with normal vision should be able to count the dots, not at 10 feet, but at 43 feet. At present, therefore, recruits may be accepted who possess less than one-fourth normal vision.

There is no regulation in the English army allowing ametropic soldiers to wear correcting glasses. Sir Thomas Longmore states that the only disadvantage accompanying such permission would be the difficulty of replacing broken lenses when their wearers were on foreign service. The German soldiers, in 1870-71, wore spectacles; and, since then, their use has been sanctioned in the French army. Perhaps when the British mind is emancipated from the thraldom of the red coat, it may give its soldiers fairer play with respect to the use of spectacles. Some day a regimental optician may accompany soldiers on foreign service.

Malingering, or feigned blindness, is stated to be rare in our army, although sufficiently common in the armies of those countries where conscription is in force. If we are to take the two illustrative cases as samples, the British Tommy Atkins does not appear to be so good at deception as he is at fighting. One of the cases is reminiscent of a half-forgotten anecdote. A soldier complained that his sight was very defective. The surgeons were unable to prove that he was shamming. One day he was suddenly ordered by a sergeant to pick up a pin from the floor, where it had been placed at some distance from him; and, taken unawares, he did so. As the text somewhat naïvely says, "He was sent back to the depot, and made no further complaint of weak sight." The author is not complimentary to his *confrères* when he says that many so-called malingerers are in reality found to be suffering from eye disease which their surgeons have been unable to detect.

The manual is profusely illustrated. Many of the illustrations are excellent, but some are of a fearful and wonderful nature. The frontispiece, representing a section of the anterior hemisphere of the globe of the eye, is, in its way, a masterpiece: the knob-like protuberance on the iris, the wormy ciliary processes, and the aggressively patent posterior aqueous chamber (which is now known to be non-existent as a space) complete a picture which belongs rather to the domain of comedy than to the province of reality.

GENERAL ASTRONOMY.

General Astronomy. By Prof. C. A. Young, Ph.D., LL.D. (Boston, U.S.A., and London: Ginn and Co., 1888.)

PROF. YOUNG is so well known in this country through his researches in solar physics, that he needs no introduction to our readers. The title of his latest work is very comprehensive, but we may at once say that it is not more so than the book itself. Every branch of the subject is touched upon more or less, although no particular branch receives very extended treatment. It is essentially a book for students, "and is meant to supply that amount of information upon the subject which may fairly be expected of every liberally educated person." For an intelligent reading of the book, only the most elementary knowledge of mathematics is necessary, but, as pointed out in the preface, the mental discipline and maturity which usually attend the later years of College life are assumed. The student is warned at the outset that astronomy, notwithstanding its important practical applications, is in the main a subject of intellectual pleasure rather than an economic one.

The general arrangement of subjects is as good as it well can be. Definitions and general considerations come first, then the various instruments are described, and these are followed by the corrections to be applied to instrumental measurements. Succeeding chapters deal with the various phenomena and problems presented by the earth, moon, sun, planets, comets, meteors, nebulæ, and stars. It is not necessary that we should refer in detail to those parts of the book dealing with the "old astronomy." Still, it may be mentioned that the treatment of Kepler's laws and the theory of lunar perturbations is especially good. We may also recommend Art. 253 to the notice of landscape painters who may be in doubt as to the representation of the moon with scientific accuracy. It would be hard to find a better account of this matter than that given by Prof. Young, and it has the great advantage of brevity.

It is in the various departments of astronomical physics that most debatable points arise, and any criticism is naturally directed there. With regard to sun-spots, Secchi's theory, with slight modifications, as previously published in Prof. Young's well-known book on the sun, is regarded as the most probable one. The theory that they are due to falls of cooled materials, however, scarcely receives justice. The objection raised is that it is not in accordance with the distribution of spots in latitude, but Mr. Lockyer has fully explained ("Chemistry of the Sun") how these spot zones may be accounted for by this theory. Obviously, if spots were produced by the fall of meteorites into the sun from any direction whatsoever, and there were no system of regulation, they would be formed all over the surface, and without espect to period. But just such a regulator as is required is to be found in the solar surroundings, and in the system of solar currents, of the existence of which evidence is constantly accumulating. Moreover, by far the greater part of spot-producing material is probably "home-made," consisting of the cool condensed products of the vapours which have been driven out from below. In the face of these explanations, it is difficult to understand why Prof. Young should have dismissed the "downrush" hypothesis with so few words.

Some people find it difficult to believe that a light body like a comet can partake of motion in an orbit just as well as a planet, but these doubters are reminded (p. 407) that a feather falls as freely as a stone in a vacuum, and that this condition holds for space.

The theory that the luminosity of comets is due to collisions between the meteorites of which they are composed appears to find little favour with Prof. Young. He remarks (p. 418) that, "although the *absolute* velocity of the comet is extremely great, the *relative* velocities of its constituent masses, with reference to each other, must be very slight—far too small apparently to account for any considerable rise in temperature or evolution of light in that way." It must not be forgotten, however, that the meteorites must have some relative velocities, owing to the differential attraction of the sun upon the swarm, and that the disturbance thus set up would be increased as the distance from the sun diminished. The number of collisions would therefore vary exactly as the brightness of comets is known to vary, and this argues strongly in favour of the collision theory of luminosity. Prof. Young attempts to get over the difficulty by suggesting (p. 418) that a gas *in the mass* may become sensibly luminous at a much lower temperature than is generally supposed, but this, we fear, is scarcely reconcilable with the kinetic theory of gases.

There is an excellent short account of the zodiacal light on p. 347, but no reference is made to its connection with the aurora, as regards its spectroscopic phenomena and its periodicity. This relation furnishes further important evidence of its meteoritic nature.

Prof. Young has evidently very little sympathy with Mr. Lockyer's new meteoric hypothesis. Only scattered references to it are made, and very little criticism is vouchsafed. The little criticism that there is seems to be based on an imperfect acquaintance with the papers already published. Thus, the collision theory of variable stars is objected to (p. 484) on the ground that it is not consistent with the irregularities in the periods, but Prof. Young is evidently under the impression that this theory limits itself to the case of a single cometic swarm revolving in an orbit round a central swarm, whereas this case was put forward as the simplest possible.

In the chapter on the classification of stars according to their spectra, both Vogel's and Secchi's classifications are given. Now, Prof. Young admits that these are based on the "doubtful assumption" that stars like Sirius and Vega are the hottest, and he further remarks that it is possible for a red star to be younger than a white one. It scarcely seems consistent, therefore, to omit the new classification suggested by Mr. Lockyer, which is the only one that takes into account the probability of there being bodies with increasing as well as with decreasing temperatures. The latter classification is certainly a very new one, but other parts of the book show that Prof. Young must have been acquainted with it.

One remark of Prof. Young's is worth quoting. After stating that there are two Observatories established solely for the study of solar physics (Potsdam and Meudon), he remarks with characteristic straightforwardness that "There ought to be one in this country (America)."

We know of no other book which is so comprehensive and at the same time so well adapted for the use of those who aim at something more than a mere smattering of astronomical knowledge. For the benefit of those whose time may be too limited to take up everything in the book, those parts which may be most conveniently omitted are printed in small type. The language is clear, and to simplify matters there are over two hundred excellent illustrations. Further, as might be expected from the fact that Prof. Young *teaches* astronomy, the book is not diluted with irrelevant matter. A. F.

AN INDEX-CATALOGUE.

The Index-Catalogue to the Library of the Surgeon-General's Office, United States Army. Vol. IX. Medicine (Popular)—Nywelt. Pp. 1054. (Washington: Government Printing Press, 1888.)

THE progress of this *magnum opus* seems irresistible. Year by year the volumes reach us with a regularity that implies strength, and a completeness that indicates a more than mechanical accuracy of work. It still remains, so far as we know, unique among printed catalogues in classifying under subject-headings, such as Mercury, Milk, Neuralgia, &c., not only the books, but also the whole of the signed medical articles in the 3500 periodicals which form the medical press of the world, from Pekin to Paris, from Newfoundland to Uruguay. The newspaper articles are still, as they have always been, collected under the subject-title only, and not under the name of the writer also; for, if the latter cross-cataloguing had been adopted, we should have had more than 300,000 cross-entries, which would have necessitated already two more volumes at least as large as the present; but those articles or essays which the authors have thought it worth while to reprint all come under their names as pamphlets, and this is no inconsiderable number.

This volume includes some names which are embarrassingly popular among medical writers. It needs a clear head to deal with a catalogue of the works of 206 authors of the name of Meyer; but when the librarian comes to Müller, he finds 343 different authors awaiting him with much more voluminous works, and he must be thankful for the great variety of Christian names, and that not more than seven besides the great physiologist contented themselves with the plain Johannes. When we notice that the librarian of the most complete professional library in England has not to do with more than eighteen and thirty-seven authors with these surnames respectively, we can form some rough comparison of their relative completeness; and the student must become aware of what a debt he owes to his Transatlantic *confrère*, who has undertaken and carried through the task of collecting and cataloguing the works of the 494 other medical authors of the same names.

In the first forty-six pages of this volume, the immense collection of facts which had been so well grouped in Vol. VIII. under Medicine, is concluded; and the two longest articles left us are those on the Nervous System, and—perhaps not unnaturally—on New York. That on the Nerves and Nervous System (103 pp.) is one of the most valuable to the student, as such a very large proportion of that rapidly-growing part of medical knowledge is embodied not in books so much as in journalistic and pamphlet literature. The strength of the historic feeling still affecting Mr. John S. Billings and his fellow-workers is shown in the great collection of sixteenth and seventeenth century literature that is to be found under such a heading as Medicine (Popular), and many others. It is very rare nowadays to find in a newly-formed collection, dating from about a quarter of a century ago, any such tendency to accumulate the materials for those great works on the history of disease which we are leaving our successors to write. That is a point towards which the strong modern development of historic research, the earnest inquiry into the origin of species of disease is gradually leading us, but even the great work of Hirsch has left us much to learn and teach, a great field for genius in tracing correctly the broad generalizations in the evolution of the morbid tendencies of men. We are a little surprised to notice the complete absence of the works of Conyers Middleton, which contributed considerably to the understanding of Roman medicine; but we have been much more surprised at the almost unimpeachable way the Index-Catalogue has stood firm in our tests on minute points of very trifling general interest.

Now that these first nine volumes have covered the ground as far as the end of the letter N, it is not unlikely that the work may be finished in five more volumes, and that at Christmas 1893 the enthusiastic student of medicine may be able to possess himself of a work not much smaller than the latest edition of the "Encyclopædia Britannica," containing a catalogue of some 150,000 medical authors, and the titles of about 600,000 of their books, pamphlets, and articles that have been got together in a generation, mainly by the untiring energy of Mr. John S. Billings. A. T. MYERS.

OUR BOOK SHELF.

The Anatomy of Megascolides australis (the Giant Earthworm of Gippsland). By W. B. Spencer. Transactions of the Royal Society of Victoria, Vol. I. Part 1, pp. 1-60, 6 Plates. (Melbourne: Stillwell and Co., 1888.)

THE Royal Society of Victoria, which has hitherto issued only an *octavo* volume of Proceedings each year, will in future publish also Transactions in *quarto*. The present memoir is the first part of this new series; the style in which it is printed and the excellent plates seem to promise that the Transactions will be quite on a level with any journal published in Europe. The illustrations are, indeed, unnecessarily large; but this cannot be pointed to as a fault—at least by those who are not responsible for the cost.

Prof. Spencer's paper is of considerable interest, particularly that section which refers to the nephridia. *Megascolides*, like *Perichæta* (as was first pointed out by Beddard, not by Perrier, as Prof. Spencer asserts), possesses a ramifying network of nephridial tubes which are continuous from segment to segment, and which open on to the exterior by numerous pores; connected with these there are—in the posterior segments of the body—a pair of large nephridial tubes in each segment, which open internally by a funnel. It is from these latter that the single pair of nephridia per segment of *Lumbricus*, &c., are to be derived; the network of minute tubules, which represents the excretory system of the flatworms, has disappeared in such forms as *Lumbricus*.

Prof. Spencer discusses the much-vexed question of the homologies of the sexual ducts, and concludes that they are not derived from nephridia.

Other points of interest cannot be touched upon in this short notice.

Lectures on Geography, delivered before the University of Cambridge, during the Lent Term, 1888. By Lieut.-General Strachey, R.E., C.S.I., President of the Royal Geographical Society. (London: Macmillan and Co., 1888.)

THESE lectures are published opportunely at a time when it is most desirable that the now almost general effort to further geographical education should be properly directed. They form a short course introductory to the work of the Lectureship on Geography now established in Cambridge, and in them General Strachey describes the aspects of the subject which he considers most suitable for the instruction of students at the University. He thus gives a complete summary of the aims and matter of scientific geography—of geography as a natural science related to other natural sciences, much as mathematics is to physical science. He assumes that students, before going to University, have acquired a general knowledge of geography; and, in passing, he points out that the primary object of the school teaching of geography is to impart an accurate knowledge of the main topographical features of the entire earth, all trivial details being omitted, and suitable instruction being given in the physical, economical, and historical characteristics of important places.

As material for the higher or University teaching of geography, the author practically claims the various branches of science which in recent years have been assembled under the term "physiography"; but he is most successful in showing that the science is not a mere patchwork, but a connected whole; and he sees no reason for abandoning the well-known name "geography." Certainly from many points of view the introduction of the new term has retarded the spread of a knowledge of the science.

An excellent epitome of the growth of our knowledge of the astronomical relations of the earth, and a short account of the methods of projection and orography, prepare the way for the history of geographical discovery. This department is reviewed in a manner at once interesting and philosophical, indicating clearly the close connection between the progress of discovery and the political movements of the world. The influence of the form and movements of the earth on terrestrial phenomena, terrestrial magnetism, our knowledge of the interior of the globe, and the relation of geology to geography, are in turn shortly discussed. The sections on land, sea, and air, and on the history of life and of man, indicate the results of recent investigation, and suggest many points which may well receive much attention from students of geography.

The lectures are written throughout in an agreeable and simple style, and will prove valuable to general readers as an elementary epitome of scientific geography.

F. GRANT OGILVIE.

A Text-book of Elementary Metallurgy for the Use of Students. By Arthur H. Hiorns. (London: Macmillan and Co., 1888.)

WE recently had occasion to notice a useful little work on practical metallurgy by Mr. Hiorns. He has now endeavoured to write a purely elementary treatise on theoretical metallurgy, adapted to the capacity of beginners. The attempt can scarcely be considered successful. In 172 pages printed in large type he deals with the whole of the wide field of metallurgy. This necessitates a very fragmentary treatment. And besides this, errors are so frequent as to render the book quite unsuited for beginners. The following examples may be cited:—The barrel method of amalgamation is stated (p. 90) to be carried on at Freiberg, where it was discontinued twenty-four years ago. One of the seven methods of producing steel is stated (p. 74) to be "by melting raw steel in crucibles." The Coppée coke-oven is described (p. 40) as being of the Appolt type. The coke-oven described (p. 42) as the Simon-Carvès is in reality a Carvès oven. The author appears to be ignorant of the existence of the principality of Catalonia, for the Catalan process is said (p. 54) to be carried on at "Catalan in the Pyrenees."

Altogether, the book compares very unfavourably with the author's work on assaying, and appears to have been hastily written. An illustration of the want of care displayed is afforded by the table of the specific gravities of eighteen metals (p. 11), in which in nine cases the figures differ from those given in the author's companion volume. With a little care, the author could have avoided such statements as—"An analogous compound, 'Boghead' of Scotland, which is a bituminous schist, is richer in bitumen than ordinary coal." Again, manganese, the author states (p. 74), "prevents the separation of carbon in the form of graphite, which is the opposite of silicon." The appendix of examination questions, covering 65 pages, appears to indicate that Mr. Hiorns's intention has been to write a cram-book for the elementary stage of the Science and Art Department's examination in metallurgy. It is, however, doubtful whether a student who made such blunders as occur in this book, would satisfy his examiners.

B. H. B.

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.*]

Weismann's Theory of Variation.

ACCORDING to Weismann ("Die Bedeutung der sexuellen Fortpflanzung für die Selektions-Theorie," Jena, 1886), heredity does not consist in the parent having the power to reproduce offspring in its own likeness, but in the property of the germ (ovum or spermatozoon) in each generation to develop into an individual of a certain invariable type. He starts from the fact that in development the germinal cells are separate from the beginning, are portions separated off from the original fertilized ovum. He distinguishes between actual and virtual differences. Different individuals developed from successive remnants of a given *Keimplasma* may show actual differences; but these are due to the action of conditions affecting the particular individual during its development and life: these differences are not inherited, cannot possibly be transmitted to the offspring, because the germ-cells in this altered individual, which were originally continuous with the germ-cell from which the individual itself developed, remain entirely unaffected by the action of the conditions on the body, and when they begin to develop have exactly the same properties as the germ-cell in the generation preceding.

Heredity, then, according to Weismann, is simply the property possessed by a germ to develop into exactly the same type in each successive generation. He says: "Ich stelle mir vor, dass die Vererbung darauf beruht, dass von der wirksamen Substanz des Keimes, dem Keimplasma, stets ein Minimum unverändert bleibt," &c.

As the action of conditions can give rise to no hereditary individual differences, these must be due to some other cause. This cause, Weismann says, is to be found in sexual, or, as Haeckel calls it, amphigonous, reproduction. Sexual reproduction consists in the fusion of two complementary germ-cells or of their nuclei: each of these germ-cells has a specific molecular structure, on which depend the hereditary tendencies of the organism whence the germ-cell is derived. Thus, in fertilization, two hereditary tendencies are mingled, and thus the offspring does not resemble exactly either of its parents, but combines the characters of each together.

In order that there shall be no ambiguity about his argument, Weismann precisely states what, according to his view, and, as he believes, in actual fact, occurs in monogonous reproduction, *i.e.* in parthenogenesis, where there is only one parent instead of two. If, in a species reproducing parthenogenetically, all the individuals were perfectly similar, all the descendants throughout any number of generations would continue similar, leaving aside evanescent differences due to conditions, and which are not hereditary. In such a case no selection, Weismann says, would be possible, and therefore no evolution in any direction.

"Processes of selection in the proper sense of the word, those which produce new characters by the gradual increase of characters already present, are not possible in species which reproduce asexually."

"If it were once proved that a species reproducing itself solely by parthenogenesis had been transformed into a new species, thereby it would be proved at the same time that other causes of modification exist than processes of selection, for by selection the new species could not have been formed."

But with sexual reproduction it is quite otherwise. Weismann points out that no two individuals of different generations could ever be similar where reproduction is sexual, and even the individuals of one family, born of the same two parents, would not be similar, because the various tendencies in the parents are present in different intensities at different times, though he gives no reason for this assumption.

According to Weismann, the individual hereditary differences so produced are the basis on which selection acts; and these differences thus explained, summed up or combined in different ways by selection, give a complete and satisfactory explanation of all organic evolution.

Now, let us examine this theory a little. For the sake of simplicity we will in most cases consider the effect of the supposed processes on one organ. In the first place, what ground is there for assuming that *Vermischung* would ever cause an increased development in the offspring of an organ possessed by the parents? Heredity, as understood by Weismann, is nothing more than the property in the germ-cell of developing into an individual like that from which it was derived. If each parent possessed a given organ in the same degree of development, a degree unaffected by external conditions, then both the ovum and the spermatozoon will, on this view of heredity, have the property of developing into an individual with the same organ developed to the same degree. When the two properties are combined by fertilization, the fertilized ovum ought to have the property of developing this character with still greater certainty, but why should it have the property of developing the character to a higher degree than that reached in either parent? By *Vermischung*, in its literal sense, the union of the two hereditary powers cannot have this effect. If by *Vermischung* it is meant that the offspring is intermediate between the two parents, then the mean of two equal characters is the same character again. And if this is what Weismann means by *Vermischung*, then a character developed to a certain degree in one parent, and not at all in the other, would in the offspring be developed to exactly half the degree in which it existed in the one. And so on. But it is obvious that in this way no increase of any character could ever occur.

But of course *Vermischung* may mean something else. It may mean that the hereditary powers of ovum and spermatozoon are added together, that the result of copulation between the germ-cells is not the mean, but the sum, of the properties of both. In this case, evolution would be extremely rapid, for each child would be equal to both its parents rolled into one. If each parent, say, among cattle, had horns equally well developed, the offspring would have horns twice as big. And it is obvious that in this way no *decrease* could ever occur, for if one parent had an organ developed and the other had no trace of it, the offspring would have it in the same degree as the one.

Now, it seems to me that, if *Vermischung* does not mean either of these things, there is only one other meaning it can have, and that is, that the hereditary powers of the copulating germ-cells reinforce one another to some extent, but not to such an extent that the result is equal to their sum. If this be the meaning, then there can never be any decrease in a character once formed. For, if every individual of a species possesses a certain organ, let us take the hind-legs in a mammal, then if two individuals which have these organs less developed than any other individuals in the species, copulate, the offspring resulting must have hind-legs better developed than either of them. Thus the whale could never have been evolved.

It follows, therefore, that, on Weismann's theory of variation, evolution is impossible. And as acquired characters are not inherited, no other theory of variation can be discovered. Therefore evolution is impossible altogether: the extremes meet, and the Darwinian principle overstrained goes rather to prove the fixity of species than their plasticity.

J. T. CUNNINGHAM.

Mr. Howorth on the Variation of Colour in Birds.

ALLOW me to assure Mr. Howorth that I have no theory to maintain. I simply called attention (*supra*, p. 318) to an overlooked hypothesis, propounded long ago, and, so far as I know, still unrefuted. Neither have I any wish to argue the question. Indeed, controversy about it is happily almost impossible, since he admits the chief fact of which I reminded him to be what he now terms (*supra*, p. 365) "an elementary postulate"—an expression far stronger than I should venture to use; but had he before shown any disposition to recognize it, my remarks had not been written. On the contrary, he implied (*supra*, p. 294) that it was a recent discovery, as it certainly appears to have been to him. I trust he will excuse me for having pointed out its want of novelty, just as he seems to excuse Prof. Geikie for pointing out the antiquity of his views as to the former climate of Siberia; and at the same time I have to ask Mr. Howorth's pardon for demurring to some of the assertions in his last communication, especially that as to the avifauna of Siberia having been "worked out from end to end." I dare not hope to see the day when this shall be done; but then I am not of a sanguine temperament.

I take this occasion to mention that in line 3 of the second paragraph of my former letter (p. 318) the word "Russian" was omitted before "explorers and naturalists." Of course it will be understood to cover Poles, as well as all those foreigners who were employed by the Russian Government.

ALFRED NEWTON.

Magdalene College, Cambridge, February 16.

Currents and Coral Reefs.

MAY I be allowed space to call attention to a remarkable fact relating to the growth of coral reefs, which has apparently (as far as I can ascertain) had no explanation, and which might assist materially in the elucidation of some problems relating to ocean currents about which—although the broad facts are known—a great deal of doubt exists? It might also give us some idea of the flow of submarine currents, the direction of which it is very difficult to determine.

It will be observed that in all coral formations there are in some places remarkable extensions of them from the land, which is not accountable for by supposing the depths only to be shallower in those directions, and the only alternative we have then is that the food supply must come chiefly from that direction, and this supply could only be kept up by currents striking the reef at these points. To give an instance of this, I might refer to the Bermudas as affording a good example of this action: there, will be seen a great extension of the reefs on the north-west side, and reefs are forming on the south-west—the Challenger and Argus Banks; and it should be noticed that these are on the edge of the Gulf Stream, and also that there are considerable eddy currents here which would cause a constant supply of food to be brought to these parts of the islands; whereas the conditions round the other parts of the islands are not so favourable, and consequently there is no extension of the reefs.

I have been much puzzled by the curious formations of coral reefs in the harbours of Suakim and Massaua and also round the island of Key West; and I have been unable to account for the peculiarities in the shape of the fringing reefs except by an hypothesis such as the above, in these cases the tidal currents taking the place of the ordinary currents.

DAVID WILSON-BARKER.

The Earthquake in Lancashire.

ON Sunday, February 10, at 10.40 p.m., there was felt here a shock as of a heavy falling body, which caused the windows to rattle loudly. Two or three seconds later a second thud-like shock was felt of somewhat greater intensity than the first. This was followed by gentle but distinct tremors, lasting, perhaps, twenty or thirty seconds more. The weather was calm at the time; the heavy snow-fall had just ceased; barometer rising after the considerable depression which had occurred during the day. The sounds appeared to come from the north-east, as if a heavy body had fallen outside a window having that aspect. Several other persons name the same quarter as that whence the sounds seemed to proceed, and in one instance, in a room having several aspects, there was a distinct statement that the north windows were the first to shake, then those in the south-west, thus indicating a possible line of movement. In most cases no direction was noted. Persons down-stairs thought something had fallen above, those in the upper stories rushed down to see what had happened below. Others, again, felt surrounded by the unwonted movement. A heavy slip of snow from the roof seemed to occur, as first thought, to most, then a colliery explosion—there are two coal-beds near—and finally an earthquake.

The chief physical effects observed here, beside the general vibration, were a violent shaking of windows, the rattling of glass and crockery, such as bed-room ware. Suspended gas-shades and pictures on walls swung as if with the wind. The doors of rooms and cupboards opened and shut, one or two ornaments fell from their brackets, and the floor is described as "rising." Most of those who slept were awakened, and seemed to suffer more alarm than those who had not retired. The movements had apparently been more severely felt by them, and they describe their beds as "rocking," and themselves being almost thrown out. None of our telephones were affected. Substantial buildings seemed less affected than those less solidly built. The various observers quoted were all in a good position to note what occurred.

T. R. H. CLUNN.

The County Asylum, Prestwich.

Can Animals count?

UNDER this heading, Sir John Lubbock, in his recent interesting book on "The Senses of Animals," gives several instances of apparent counting in the case of insects. He says:—

"One species of Eumenes supplies its young with five victims, one ten, another fifteen, and one even as many as twenty-four. The number is said to be constant in each species. How, then, does the insect know when her task is fulfilled? Not by the cell being filled, for, if some be removed, she does not replace them. . . . In the genus Eumenes, the males are smaller than the females. . . . In some mysterious manner the mother knows whether the egg will produce a male or a female grub, and apportions the quantity of food accordingly. She does not change the species or size of her prey; but if the egg is male, she supplies five, if female, ten, victims. Does she count? Certainly this seems very like a commencement of arithmetic."

Now, it seems to me that this can be explained in a far simpler and more probable manner than by supposing that insects have any power of counting. I think we may safely consider—

(1) That a certain *average amount* of food is required in each case.

(2) That a certain *average time* is required by the insect to collect this food.

(3) That the eggs of the insect follow one another at a *certain rate*, over which she has little or no control.

(4) That the eggs which are to produce *males*, being smaller, take less time to form, and follow at shorter intervals, than do those which are to produce *females*.

Now take the case of the Eumenes which provides ten victims. She makes the cell, and goes on adding caterpillars until the egg comes to maturity and is laid, and the cell finished off. She then repeats the process, laying the egg when it comes to maturity, as before; the interval between the laying of one egg and the next being long enough, on the average, to provide ten victims, or in case the egg is to produce a male, the smaller interval only allows of five being provided.

There is thus no need to credit the insect with any power of *counting*, or of knowing beforehand anything about the sex of the eggs. It is merely another instance of the perfect way in which, by the process of evolution, means are adapted to ends.

The same explanation applies to the cases mentioned on pp. 254–56 of "The Senses of Animals." The bee laboured to fill the cell (in which a hole had been made so that the honey ran out again), until, "when she had brought the usual complement of honey, she laid her egg, and gravely sealed up the empty cell: . . . in some mysterious manner the bee feels when she has provided as much honey as her ancestors had done before her, and regards her work as accomplished."

I should suggest that the bee merely goes on bringing honey until the *egg is ready*. She then starts another cell, and goes through the same routine until the next egg is ready, and so on; the average amount of honey collected being proportional to the interval between the laying of one egg and the next. According to the theory of evolution, this interval is just sufficient for enough food to be provided for the use of the grub.

G. A. FREEMAN.

St. Olave's Grammar School, Southwark.

Weight and Mass.

MR. ANDREW GRAY need only turn to p. 355 of the current number of NATURE to find an example of an engineer's dynamical terminology, and it would tend to some useful result in this interminable discussion if he would point out in what manner the language of the engineer must be modified to suit the requirements of the *precisionist*. We find on p. 355 "the working pressure is 175 pounds per square inch," "the total weight of the engine in working order is 37 tons," "probably having about 30 tons useful weight for adhesion," and so on.

Let Mr. Andrew Gray point out what he considers the errors of the engineers. Ought the engineer to say, "the working pressure is 175 pounds weight (or pound weights?) per square inch," "the total mass of the engine is 37 tons," "probably having about 30 tons useful (? mass or weight) for adhesion."

On former occasions in this controversy I have attempted to elicit definite expressions of opinion on the terminology of similar definite actual dynamical problems, but hitherto without success.

A. G. GREENHILL.

Woolwich, February 12.

Detonating Meteor.

MR. MAXWELL HALL's letter on this subject is of considerable interest. When the great meteor-shower of November 11–15 was traced to the orbit of the comet of 1866, it was natural to suppose that the fine fire-balls which occur about this period belong to the same series. Plainly, however, the Jamaica fire-ball recorded by Mr. Hall had a southern radiant far distant from that of the well-known Leonid shower. The same thing was noticed in the case of the shower of aërolites which fell in France on the 13th of November, 1835, the motion being south-east to north-west; and in many other instances in which fire-balls or aërolites were observed within this period the phenomena seem to agree best with a southern radiant, though the descriptions are not as full as we could desire. It thus appears highly probable that almost concident in time with the well-known Leonid shower there is another shower, rich in fire-balls and aërolites, proceeding from a southern radiant. I hope it will be watched from southern stations in future.

W. H. S. MONCK.

Dublin, February 15.

Ice Planed.

PERHAPS it will interest some of those who are investigating the structure of different kinds of ice to know how blocks of it may, with ease and certainty, be shaped into bars and plates of any required dimensions. Some time ago I had occasion to prepare some specimens for experimental purposes. At first my success in working the ice into the required form was not very great, for it cracked in all directions under the action of a saw or chisel. After trying many devices, I at last resorted to a joiner's plane; a tool which may have been tried for the purpose before, though I do not remember having seen its use suggested. With it ice may be planed with greater ease than wood, the shavings coming away in powder, and leaving the ice with a clean, bright, sound surface. R. M. DEELEY.

39 Caversham Road, Kentish Town, N.W., February 16.

REPETITION OF HERTZ'S EXPERIMENTS, AND DETERMINATION OF THE DIRECTION OF THE VIBRATION OF LIGHT.

SINCE last October, Prof. Fitzgerald and I have been repeating some of Prof. Hertz's experiments, as occasion allowed; and it may not be without interest at the present time to give a short account of our work.

The first experiment tried was the interference of direct electro-magnetic radiation with that reflected from a metallic sheet. This experiment is analogous to that known in optics as "Lloyd's experiment."

The radiation was produced by disturbances caused in the surrounding space by electrical oscillations in a conductor. It was arranged in this wise. Two thin brass plates, about 40 centimetres square, were suspended by silk threads at about 60 centimetres apart, so as to be in the same plane. Each plate carried a stiff wire furnished at the end with a brass knob. The knobs were about 3

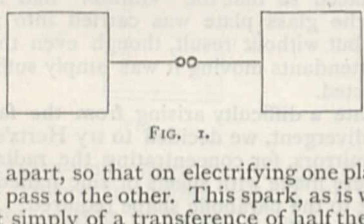


FIG. 1.

millimetres apart, so that on electrifying one plate a spark could easily pass to the other. This spark, as is well known, consists not simply of a transference of half the electricity of the first plate to the second—though this, which is the final state, is all that is observable by ordinary experimental methods—but the whole charge passes across to the second plate, then returns, and so on, pendulum-fashion, the moving part of the charge becoming less each time, till finally brought to rest, the energy set free at sparking being converted partly into heat in the wire and air break, partly into radiation into space, or in terms of action at a distance in inducing currents in other bodies.

The time taken by the charge to pass over to the second plate and to return, is a definite thing for a given sized arrangement, and depends on the connection between them. If C be the capacity of the plates, and I the self-induction of the connection, the time of each complete oscillation equals $2\pi\sqrt{CI}$. The time in the case of the particular arrangement used is, speaking roughly, about the 1/30,000,000 of a second.

If there be conductors in the neighbourhood of this "vibrator," currents will as usual be induced in each on every passage of the charge between the plates, each passage serving simply as a primary current.

Now, speaking briefly, the whole object of the experiment is to find out if these induced currents take place simultaneously in conductors situated at various distances from the primary current, and if not, to determine the delay. In order to do this we must, in the first place, be possessed of some means of even ascertaining that these currents occur, all ordinary methods being inadequate for detecting currents lasting only for such exceedingly short periods as these do. By devising how to determine the existence of these currents, Hertz made the experiment possible.

His method depends on the principle of resonance, previously suggested by Fitzgerald, and his current-observing apparatus is simply a conductor, generally a wire bent into an unclosed circle, which is of such a length that if a current be induced in it by a passage of a charge across the "vibrator" the return current or rush back of the electricity thus produced in the ends of the wire occurs simultaneously with the next impulse, due to the passage back across the "vibrator."

In this way the current in the "resonator" increases every time, so that at last the end charges, which are always of opposite sign, grow to be so great that sparks will actually occur if the ends of the wire are brought near together. Thus, Hertz surmounted the difficulty previously experienced by Fitzgerald when proposing electro-magnetic interference experiments.

The time of vibration in this circle is, as before, $2\pi\sqrt{CI}$, but on account of difficulties in calculating these quantities themselves, the length of the wire is most readily found by trial. To suit the "vibrator" we used, it was about 210 centimetres of wire No. 17. The ends of the wire were furnished with small brass knobs, which could be adjusted, as to distance between them, by a screw arrangement, the whole being mounted on a cross of wood for convenience in carrying about.

At first sight the simplest "resonator" to adopt would seem to be two more plates arranged similarly to the "vibrator," but it will be seen on consideration that it would not do, because no break for seeing the sparking could be put between the plates, for, if it were, the first induced current would be too feeble to jump the break, so that the reinforcement stage could never begin.[1]

The charging of the "vibrator" was effected by connecting the terminals of an induction-coil with the plates. In this way a continuous shower of sparks could be obtained in the resonating circle.

The circle in the interference experiment was held in the horizontal plane containing the axis of the "vibrator," the ends of the circle of wire being in such a position that a line joining the knobs was at right angles to the "vibrator." In this position only the magnetic part of

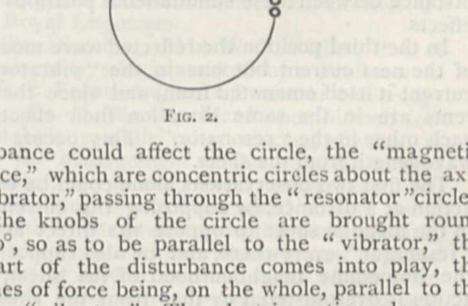


FIG. 2.

the disturbance could affect the circle, the "magnetic lines of force," which are concentric circles about the axis of the "vibrator," passing through the "resonator" circles.

When the knobs of the circle are brought round through 90°, so as to be parallel to the "vibrator," the electric part of the disturbance comes into play, the electric lines of force being, on the whole, parallel to the axis of the "vibrator." The electric action alone can cause a forced vibration in the knobs, even when the connecting wire is removed, if placed fairly close to the "vibrator."

[1] However, two pairs arranged in line, the pairs connected by a wire, could probably be got to spark between the centre plates.

Again, if the knobs be kept in this position, but the circle be turned through 90°, so that its plane is vertical, only the electric part can act, the magnetic lines of force just grazing the circle. In this way the disturbance can be analyzed into its magnetic and electric constituents.

Lastly, if the knobs be in the first position, while the circle is vertical, there will be no action.

To exhibit these alone forms an interesting set of experiments. It also makes a very simple and beautiful experiments to take a wire twice as long and fix it instead of the first, but with two turns instead of one; no sparking is then found to occur. This is, of course, quite opposed to all ordinary notions, double the number of turns being always expected to give double the electromotive force. In this way the reality of the resonance is easily shown.

Interference Experiment.—The sparking, of course, becomes less intense as the resonator is carried away from the "vibrator," but by screwing the knobs nearer together it was possible to get sparks at 6 and 7 metres away. On bringing a large sheet of metal (3 metres square, consisting of sheet zinc) immediately behind the "resonator," when in sparking position, the sparking increased in brightness, and allowed the knobs to be taken further apart without the sparking ceasing; but when the sheet was placed at about 2·5 metres further back, the sparking ceased, and could not be obtained again by screwing up the knobs. On the other hand, when the sheet was placed at double this distance (about 5 metres), the sparking was slightly greater than without the sheet.

Now these *three* observations can only be explained by the interference and reinforcement of a direct action of the "vibrator" with one reflected from the metallic sheet, and in addition by the supposition that the action spreads out from the vibrator at a finite velocity. According to this explanation, in the first position the reflected part combines with the direct and reinforces its effects. In the second position—that of no sparking—the reflected effect, in going to the sheet and returning, has taken half the time of a complete vibration of the "vibrator," and so is in the phase opposite to the incident wave, and consequently interferes with it.

If it were possible to tell the direction of the current in a "resonator" at any moment, then, by employing two of them, and placing one just so much beyond the other that the currents induced in them were always in opposite directions, we would obtain directly the half-way length. Now, by reflection we virtually are put in possession of two "resonators," which we are enabled to place at this distance apart, although unable to tell more than whether there be a current or not.

The distance from the position of interference to the sheet is a quarter of the wave-length, being half the distance between these simultaneous positions of opposite effects.

In the third position the reflected wave meets the effect of the next current but one in the "vibrator" after the current it itself emanated from, and since these two currents are in the same direction their effects reinforce each other in the "resonator." This occurs at half the wave-length from the sheet.

The first two observations alone could be explained by action at a distance, by supposing the currents induced in the metallic sheet to oppose the direct action in the "resonator" everywhere, and by also supposing that, in the immediate neighbourhood of the sheet, the direct action is overmastered by that from the sheet, while at 2·5 metres away the two just neutralize each other.

On this explanation, at all distances further the direct action should be opposed by that from the sheet, so that the fact of being increased at 5 metres upsets this explanation. Again, behind the sheet, evidently on this supposition, the two actions should combine so as to increase the sparking, but instead of this the sparking was found to cease on placing the sheet in front of the "resonator."

In performing these experiments the "resonator" circle was always placed in the position in which only the magnetic part of the disturbance had effect. Hertz has also used the other positions of the resonating circle, whereby he has observed the existence of an electric disturbance coincident with the magnetic one, the two together forming the complete electro-magnetic wave.

Ordinary masonry walls were found to be transparent to radiation of this wave-length—that is, of about 10 metres—and some visitors to the opening meeting of the Dublin University Experimental Society, last November, were much astonished by seeing the sparking of the resonating circle out in the College Park, while the vibrator was in the laboratory.

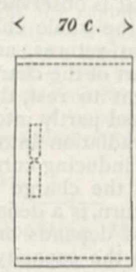
Attempts were first made last December to obtain reflection from the surface of a non-conductor, with the hope of deciding by direct experiment whether the magnetic or electric disturbance was in the plane of polarization; that is, to find out whether the "axis of the vibrator" should be at right angles to the plane of reflection or in it, when at the polarizing angle, for obtaining a reflected radiation. It is to be observed that in these radiations the electric vibration is parallel to the "axis of the vibrator" while the magnetic is perpendicular to it, and that they are consequently polarized in the same sense as light is said to be polarized.

Two large glass doors were taken down and used for this purpose, but without success; and until lately, when reflection from a wall was tried, the experiment seemed unlikely to be successful.

In working with the glass plate, the resonator circle was first placed so that the "vibrator" had no effect on it. Then the glass plate was carried into position for reflection, but without result, though even the reflection from the attendants moving it was amply sufficient to be easily detected.

To obviate a difficulty arising from the fact that the wave was divergent, we decided to try Hertz's cylindrical parabolic mirrors, for concentrating the radiation. Two of these were made with sheets of zinc nailed to wooden frames, cut to the parabolic shape required.

In the "focal line" (which was made 12·5 centimetres from the vertex) of one of these, a "vibrator" was



Side elevation.

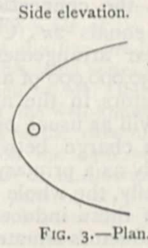


FIG. 3.—Plan.

placed, consisting of two brass cylinders in line, each about 12 centimetres long and 3 centimetres in diameter, rounded at the sparking ends.

In order that the "resonator" wire may lie in the "focal line" of the receiving mirror, it has to be straight;

this necessitates having two of them. They each consist of a thick wire 50 centimetres long, lying in the "focal line," and of a thin wire, 15 centimetres long, attached to one end at right angles, and which passes out to the back of the mirror through a hole in the zinc, where the sparking can be viewed, without obstructing the radiation in front. The total length of each "resonator" is about two wave-lengths, the wave-length being about 33 centimetres, so that it may be that there are two vibrating segments in each of these "resonators."

With this apparatus it is possible to deal with definite angles of incidence. No effect was obtained with glass plates using these mirrors, whether the "vibrator" was perpendicular to the plane of reflection or in it. But with a wall 3 feet thick reflection was obtained, when the "vibrator" was perpendicular to the plane of reflection; but none, at least at the polarizing angle,[1] when turned through 90° so as to be in it.

This decides the point in question, the magnetic disturbance being found to be in the plane of polarization, the electric at right angles. Why the glass did not reflect was probably due to its thinness, the reflection from the front interfering with that from the back, this latter losing half a wave-length in reflection at a surface between a dense and a rare medium; and, as Mr. Joly pointed out, is in that case like the black spot in Newton's rings, or more exactly so, the black seen in very thin soap-bubbles. Hertz has pointed out several important things to be guarded against in making these

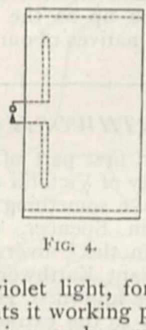


FIG. 4.

experiments. Ultra-violet light, for example, falling on the "vibrator," prevents it working properly, the sparking in the resonator ceasing or becoming poor. Also, the knobs of the "vibrator" must be cleaned, of burnt metal, and polished every quarter of an hour at least, to prevent a like result.

Both these effects probably arise, as suggested by Mr. Fitzgerald, from a sort of initial brush discharging (either ultra-violet light or points being capable of doing this), which prevents the discharging impulse being sufficiently sudden to start the oscillation in the "vibrator." For, to start a vibration, the time of impulse must be short compared with the time of oscillation. These precautions, therefore, become especially needful when working with small-sized "vibrators." Possibly, charging the "vibrator" very suddenly, after the manner of one of Dr. Lodge's anti-lightning-rod experiments, would save the irksome necessity of repeatedly cleaning the knobs of the "vibrator."

Several important problems seem to be quite within reach of solution by means of these Hertzian waves, such as dispersion. Thus, it could be tried whether placing between the reflector and the "resonator" conducting bodies of nearly the same period of vibration as the waves used would necessitate the position of the "resonator" being changed so as to retain complete interference. Or again, whether interspersing throughout the mass of a large Hertzian pitch-prism conductor with nearly the same period would alter the angle of refraction. In some such way as this, anomalous dispersion, with its particular case of ordinary dispersion, may yet be successfully imitated.

[1] Slight reflection was obtained at an incidence of 70°.

The determining the rate of propagation through a a large tile, or sheet of sandstone, could be easily made by means of the interference experiment, by placing it between the screen and the "resonator."

FRED. T. TROUTON.

THE SCHOOL OF FORESTRY AT DEHRA DOON, INDIA.

LAST year we gave an account of the newly-established School of Forestry at Cooper's Hill, the first of the kind in the United Kingdom, and explained what kind of instruction was there given, and how it was suited to the training of officers for the Indian Forest Department. We now propose to say something of its brother in India—an elder brother, indeed, by some eight years—the School at Dehra Doon, in the North-Western Provinces, now engaged in the education of those who may, not inaptly, be called the non-commissioned officers of the Department. The Dehra Doon is a long valley, which lies at the foot of that portion of the Himalaya which stretches between the great rivers Jumna and Ganges. It is shut off from the great Gangetic plain by a range of hills called the "Siwaliks," known well to all students of palæontological geology as the range in which were found the wonderful series of bones of extinct mammals described by Messrs. Falconer and Cautley. The valley itself lies about 2000 feet above the level of the sea, possesses a beautiful climate free from the blasts of the hot winds which, in April to June, sweep over the plains to the south of it; and is further known historically as having been the site of the first experiments made by the Indian Government in growing the tea-plant, experiments which proved its suitability to India, and made the Doon the fatherland of the great Indian tea industry—an industry which has gradually increased to such an extent that the exports of tea from India and Ceylon now very nearly rival in amount those from the Chinese Empire. Centrally situated in this beautiful valley, among plantations of tea, forests of sál-wood, and groves where the deodar of the Himalaya may be seen alongside of the mango, typical of the Indian plains, and feathery bamboos raise their heads from an undergrowth in which wild or semi-wild roses thrive with luxuriance, lies the town of Dehra Doon, the head-quarters of a Deputy-Commissioner, of the offices of the great Trigonometrical Survey of India, of a regiment of Ghoorka troops, and of the body-guard of the Viceroy. It is rather a straggling town, like most similar Indian stations; but, centrally situated and surrounded by gardens, is found the Forest School, of which we wish to convey some idea to our readers. The School was first started, in 1878, by the exertions of the then Inspector-General of Forests, now Sir Dietrich Brandis, K.C.I.E., and the first Director was Lieut.-Colonel F. Bailey, of the Royal Engineers.

At present the Director is Mr. W. R. Fisher, B.A. of Cambridge University, who is assisted by a Professor of Forestry, Mr. E. E. Fernandez, and a Professor of Geology and Chemistry, Dr. H. Warth. Mr. Fisher himself lectures on forest botany, while other officers, attached to the School for the management of the adjacent forests, teach mathematics, forest law, forest entomology, and surveying, the teaching of the last-named subject being especially fostered by the presence, in the same building, of the office of the Forest Survey, which is now engaged in the preparation of careful detailed maps of the great forest estate which Government possesses in India, and which bids fair to become, not only by its agricultural and climatic effects, but by its financial success, one of the most valuable of the revenue-yielding departments of the Empire.

Attached to the School is a well-equipped museum, containing a magnificent collection of accurately-named

Indian woods; an herbarium, a chemical laboratory, and a meteorological observatory; while the forests of three districts are attached to the School as a training-ground, in which the young students may learn, by personal and actual experience, the conduct of forest operations in the field. The students are usually selected in the different provinces by the Conservators of Forests, and are generally young officers who have seen already some preliminary service. Several have been deputed by the chief native States, such as Mysore and Baroda, and this shows the spread that an enlightened forest policy is making in the country. There are, besides, a number of independent students, who study in the hope of obtaining appointments if successful, either in the British territory or in the native States.

Two courses of study are carried on at the School, the higher in English, leading up to the ranger's certificate, which qualifies the students who succeed in obtaining it for the appointment as "Forest Ranger," on salaries rising from Rs. 600 to Rs. 3000 yearly; the lower, in Hindustani, leading to the forester's certificate, which qualifies the holder for appointments of from Rs. 240 to Rs. 480 per annum. The ranger's course lasts twenty-one months, of which eight are spent in theoretical instruction, and the rest in practical work in the field. The subjects taught are forestry, botany, the elements of zoology, chemistry, physics, geology, mathematics, and surveying, with elementary engineering, such as road-making and the construction of forest export works, and forest law. The forester's course lasts sixteen months, four in theoretical study, and the rest in the field, and the subjects taught are elementary forestry and botany, mathematics, surveying and plan-drawing, and departmental procedure.

The students wear a neat uniform of *kharki*, drill with a turban or helmet, and they are regularly exercised in drill, most of the European and Eurasian students, however, preferring to join the Dehra Doon Corps of Mounted Infantry. When on tour in the forests on practical instruction, each has a small tent, with furniture of a camp-table, chair, and bedstead, and some of them amuse themselves occasionally in sport, one student last year distinguishing himself by carrying off the first prize for shooting in the province.

The forests attached to the School Circle consist of those of the Dehra Doon, Saharanpore, and Jaunsar Forest Divisions. The two former contain chiefly forests of the sál tree (*Shorea robusta*), the chief gregarious tree of India, and the most valuable timber, for building purposes, after teak. They occupy respectively the northern and southern slopes of the Siwalik Range, and are carefully managed as training forests. The Dehra Doon forests are now being worked under a working plan prepared by Mr. Fernandez, the Professor of Forestry. These forests had, till some twenty years ago, been very badly treated, so that at present the older portion of the stock consists chiefly of trees which are crooked and unsound, the good and sound ones having previously been all cut out to provide sleepers for the East Indian, and Sind, Punjab, and Delhi Railways. The present working plan provides for a temporary rotation of twenty years, during which (1) all the old, unsound, and crooked sál trees which can be cut without letting in too much light are removed; and (2) all trees of the less valuable kinds that are not required for shade are cut away. These operations have now been carried on for a few years with the most beneficial results, for the ground is being rapidly covered with good and straight saplings and coppice shoots of sál. The forest operations, the selection of the trees to be cut, and their marking and enumeration, are all done by the students themselves, so that in this way they obtain a valuable amount of practical experience.

The forests of Jaunsar lie on the hills of the outer Himalaya at an elevation of some 5000 to 10,000 feet, and consist chiefly of coniferous trees. The deodar cedar (*Cedrus Deodara*) is, of course, the most valuable of these; then come the pines, the "kail" (*Pinus excelsa*), which so often accompanies the deodar, and the "chir" (*Pinus longifolia*), which forms gregarious forest at the lower elevations. The silver and spruce firs (*Abies Webbiana* and *Smithiana*) also occur, as well as oaks (*Quercus incana*, *dilatata*, and *semicarpifolia*) and other temperate trees. These forests are also carefully treated under working plans, and in them the students of the School learn the management of coniferous forests, the extraction of timber by roads and slides, the planting of blanks in the forest, and the measures necessary for protection against fire and frost.

At the end of their course, and on obtaining their certificates, the students return to the provinces from which they were sent, qualified to carry out ordinary forest works in their own country; and some of them have already obtained promotion into the higher staff of the Department as the reward of their good work, industry, and energy.

The Forest School at Dehra Doon may thus be said to be doing an excellent work, a work which cannot fail to have the best possible effect in the country, and to show the truth of Sir Edwin Arnold's saying that "the Forest Conservancy carried out by the British 'Râj' is one of the greatest benefits to the peninsula."

Soon, perhaps, the extension of forest work will necessitate the establishment of other or branch establishments in Madras, Burmah, and elsewhere; but it is to Dehra Doon that all will look up as the pioneer of scientific forest teaching for the natives of our great dependency.

THE GIANT EARTHWORM OF GIPPSLAND.

THE recently-issued first part of the Transactions of the Royal Society of Victoria contains an elaborate essay (of which we have something to say elsewhere to-day) by Mr. Baldwin Spencer, the newly-appointed Professor of Zoology in the University of Melbourne, on the anatomy of the Giant Earthworm of Gippsland, the largest earthworm yet known. This worm, of which some examples attain to the extraordinary length of six feet, was first described by Prof. McCoy in 1879, and named *Megascolides australis*. It belongs to a peculiar Australian group, of which five species are now known. Mr. Spencer gives us the following general account of its habits:—

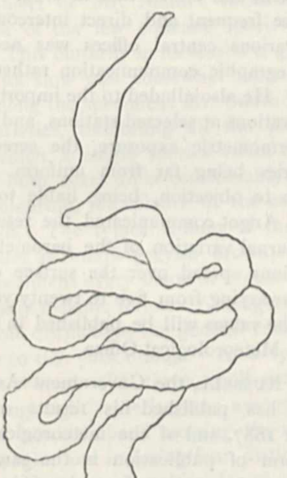
Of all the species of *Megascolides* yet known, this one seems to be the largest, and is apparently confined to Gippsland; it is, when found at all, somewhat abundant, and lives principally on the sloping sides of creeks. At times it is found beneath fallen logs, and may be turned out of the ground by the plough.

When first seeking it, we were somewhat puzzled by some of those who were evidently well acquainted with the worm assuring us that the entrance to its burrow was indicated by a distinct "casting"; whilst others, evidently equally well acquainted with the animal, were quite as positive in asserting that it never produced any "casting." Whilst searching, we found what I believe to be the explanation of the contradictory statements, and soon discovered that the surest test of the presence of the worm underground was a very distinct gurgling sound, made by the animal retreating in its burrow when the ground was stamped upon by the foot. When once heard, this gurgling sound is unmistakable, and we at once learnt to regard it as a sure sign of the worm's presence.

The worm very frequently lives in ground riddled by the holes of the land-crab, as it is popularly called; this animal has a small circular burrow leading down to a chamber hollowed out underneath containing a pool of water, and through these chambers the worms' burrows frequently pass. The "crab" almost invariably has a large conical "casting" at the entrance to its hole, and may raise this to a height of even a foot and more; but the true worm-burrow never, so far as yet observed, has any "casting" at its entrance, and all trace of this is wanting where the crab-holes are absent. The very frequent association of the "crab" and worm leads to the idea that the latter forms a cast; but one of the most noticeable features of the ground, which is at times riddled with worm-burrows only, is the entire absence of "castings." What the worm does with the immense quantity of earth which it passes through its body I cannot at present say, and it must also be noticed that only on very rare occasions can any trace be detected of leaves dragged down into the burrows.

It is no easy matter to extract the worm without injury, owing to its length, the coiling of the burrow, the rapidity of movement which it possesses when underground, and its power of distending either the anterior or posterior ends of the body, or both.

Directly the burrow is laid bare, the worm is seen gliding rapidly away, often producing the curious gurgling sound as it passes through the slimy fluid always



Megascolides australis. Drawing of McCoy's figure ("Prodr. Zool. Vict.," i. pl. vii.).

present in a burrow containing the living animal. Sooner than allow itself to be drawn out, it fixes, if held in the middle, both ends of its body by swelling them out till they are tightly jammed against the sides of the burrow; under these circumstances, pulling merely results in tearing the body. The worm has been described as brittle, but this term is most inapplicable, as its body is very soft, and capable of a great amount of extension before tearing. Its curious smell, when living, resembling somewhat that of creosote, has been already observed by Prof. McCoy, and, when dead, it is worse than ever, and very strong and characteristic; the body, in decaying, passes into an oily fluid, which, we were assured by one or two old natives of the district, is very good for rheumatism. Fowls refuse to touch the worm, living or dead.

When held in the hand, the worm, in contracting its body, throws out jets of a milky fluid from its dorsal pores to a height of several inches; if the burrow be examined carefully, its sides are seen to be very smooth, and coated over with a fluid exactly similar to that ejected from the pores. Whatever be the primary function of the fluid when within the body-cavity, there can be no doubt that it has the important and perhaps secondary function, when it has passed out of the body, of making the burrow walls smooth, moist, and slippery, and of thus enabling the animal to glide along with ease and speed.

The worm in its burrow moves rapidly by swelling up its anterior or posterior end, as the case may be, and then, using this as a fixed point, in doing which the setæ perhaps help, though to a minor extent, it strongly contracts the rest of its body. In the next movement, the end free in the first instance will be swollen out and used as a fixed point, from which expansion forwards can take place. These changes of motion follow each other so rapidly, that in the burrows the appearance of continuous gliding is given. Outside the burrow, when the whole body-surface is not in contact with the earth, the worm makes no attempt whatever to move, lying passively on the ground. Anyone who merely sees the beast removed from its burrow imagines it to be of a very sluggish temperament, and can form no idea of its active and rapid movements when underground.

So far as locomotion is concerned, its setæ seem to be of little or no use to it. The perichæte worms, on the contrary, when taken from the burrow, move along on the ground with remarkable speed, certainly using their setæ as aids to progression.

The burrows of the large worm measure ¾–1 inch in diameter; and in disused ones are often found (1) casts of the worms, or rather, what are probably the earthy contents of the alimentary canal, with clear indications marked upon them of the segments of the body; and (2) more rarely cocoons. The latter measure 1½–2 inches in length, vary from light yellow to dark brown in colour, according to their age, and contain only one embryo each, which I have at present only been able to obtain in a somewhat highly developed state.

The cocoon itself is somewhat thin, and made of a tough leathery material, with a very distinct stalk-like process at each end; it contains a milky fluid, closely similar to that found in the body-cavity of the worm.

It is interesting to note the fact that at the present time we know of three especially large kinds of earthworms; that, of these, one comes from South Africa, another from the southern parts of India and Ceylon, and the third from the south of Australia. We know as yet little about the distribution of earthworms, but the same laws which governed the distribution of other animals must also have governed theirs, and it is just possible that these great earthworms may be the lingering relics of a once widely-spread race of larger earthworms, whose representatives at the present day are only found, as occurs with other forms of life, in the southern parts of the large land-masses of the earth's surface. Possibly careful search will reveal the existence of a large earthworm in the southern parts of South America.

NOTES.

In reply to his letter in our columns on the 7th inst. (p. 341), Mr. Sclater has received applications from several unexceptionable candidates for the post of Naturalist to the Pilcomayo Expedition. Out of these, Captain Page has agreed to select Mr. Graham Kerr, of the University of Edinburgh, to accompany him. Mr. Kerr is most highly recommended by Prof. Balfour, Prof. Geikie, and Prof. Ewart as in every way suited for the work. He will leave England for Buenos Ayres about the beginning of June.

It has now been definitely arranged that the steamer *Hvidbjörnen* shall leave Copenhagen on March 15 for Greenland, in order to bring back the members of the Nansen Expedition. The vessel will, however, not be back in Copenhagen until the beginning of June. After a few days' sojourn in that city, Dr. Nansen will proceed direct to Bergen, and prepare a work on his expedition and its scientific results.

IN the presence of a distinguished company of men of science, the King of Sweden recently opened the sealed papers containing the names of the two successful competitors for the mathematical prizes offered by him five years ago. The successful competitors were found to be Prof. H. Poincaré, of the Faculté des Sciences, Paris, who receives £160, and M. Paul Appert, Professor in the same Faculty, who receives a gold medal valued at £40. The papers, with reports by Profs. Weierstrass and Hermite, will be published in the *Acta Mathematica*. Twelve papers were sent in for the competition.

WE regret to have to record the death, at the early age of twenty-four, of a biologist of great promise, Mr. Richard Spalding Wray, B.Sc. Lond. The son of the Rev. William Wray, a Nonconforming minister in Yorkshire, he early developed a strong taste for natural history pursuits, which led him to become a student at the Normal School of Science at South Kensington, where he eagerly followed the teaching of Prof. Huxley and Mr. Howes. When, at the close of the year 1884, the present Director of the Natural History Museum was seeking some one to assist him in the formation of an elementary series of biological preparations to be placed in the great hall of the Museum, as an introduction to the study of the subjects more fully developed in the special galleries, he fortunately became acquainted with Mr. Wray, who entered with enthusiasm into the project, and soon showed that he possessed every natural capacity requisite for such a work. A neat-handed, skilful dissector, a good mechanician, an excellent draftsman, he displayed great taste and ingenuity in carrying out and often improving upon every suggestion made to him by the Director. While he was engaged in the formation of a series of preparations to illustrate the arrangement of the bones and feathers of the wings of birds, the very insufficient state of the knowledge upon the subject as recorded in ornithological works became apparent, and Mr. Wray made some valuable original observations, which were embodied in a paper "On some Points in the Morphology of the Wings of Birds," published in the Proceedings of the Zoological Society for 1887. This and two minor papers on kindred subjects were all that he was able to communicate to the world, for, unhappily, his powers were greatly diminished by long-continued ill-health, which finally developed into pulmonary phthisis, to which he succumbed on the 12th of this month. He has, however, left a lasting memorial of his patience, ability, and knowledge in the preparations which enrich the Museum; and his simple, modest, unaffected character, and the genuine earnestness with which he entered into the performance of every duty, will not be easily forgotten by those who had the pleasure and advantage of being in any way associated with him.

THE Hunterian Oration was delivered on Thursday last, in the theatre of the Royal College of Surgeons, by Mr. Henry Power, senior ophthalmic surgeon to St. Bartholomew's Hospital. Speaking of Hunter's career as a student, Mr. Power pointed out that he took six or seven years to learn anatomy and surgery, whereas in the present day a medical student has only four years to acquire a knowledge of many more subjects. Mr. Power urged that another year is necessary, that it is, in fact, taken by the best students, and that it should be compulsory on all. This, he thought, could be easily obtained if every student were obliged to pass a thoroughly practical examination in chemistry, physics, and elementary biology, before being permitted to register.

IN a letter addressed to MM. Henry, of the Paris Observatory, and printed in *La Nature* (February 16), Mr. J. A. Brashear says that the Photographic Society of San Francisco obtained 167 negatives of the recent solar eclipse, the majority of them being very successful. Mr. Brashear himself was able to do good work at Winnemucca, Nevada.

THE Naples Correspondent of the *Times*, writing on the 14th inst., says:—"On the 12th inst. a perpendicular shock of earthquake was felt here, lasting about four seconds. It was stronger at the Observatory of Vesuvius, and in the towns at the foot. After the lapse of a minute another shock, the return shock, was felt at the Observatory. 'Meanwhile,' says a reporter from the spot, 'small streams of lava continue to run down on the eastern side, and at the time when we are writing the seismograph is less animated.'"

THE Paris Correspondent of the *Daily News*, telegraphing on Tuesday, February 19, says:—"The district of Pont de Beauvoisin, in the Department of the Isère, was disturbed yesterday by a shock of earthquake which lasted about three seconds. Many houses were violently shaken. Field labourers were very much frightened. A good many villages suffered from it, but no lives appear to have been lost."

AT the meeting of the French Meteorological Society on January 15, the President, M. Renou, on taking that office for the third time, delivered an address on the progress of meteorology since the establishment of the Society in 1853. He referred to the great improvement that had taken place in the construction and use of the various instruments, and to the progress made in weather prediction, and stated that in order to further improve the system more frequent and direct intercourse by telegraph between the various central offices was necessary, and the extension of telegraphic communication rather than refinement in observations. He also alluded to the importance of automatic or hourly observations at selected stations, and to the differences existing in thermometric exposure, the screens employed in different countries being far from uniform. (That used in France is open to objection, being liable to the influence of radiation.) M. Angot communicated the results of his discussion on the diurnal variation of the barometer, deduced from above fifty stations spread over the surface of the globe, and based on means varying from five to twenty years and upwards. The whole of the values will be published in the Annals of the French Central Meteorological Office.

MR. H. C. RUSSELL, the Government Astronomer of New South Wales, has published his results of rain and river observations for 1887, and of the meteorogical observations for 1886. The form of publication is the same as before (see NATURE, vol. xxxvi. pp. 546 and 566), but the amount of valuable materials dealt with is continually increasing. The rain and river stations for which monthly and annual observations are given amount to 866.

IN their fifth Annual Report on the Museum of General and Local Archæology, the Antiquarian Committee of the University of Cambridge call attention to a discovery of unusual interest made in Cambridge at the beginning of 1888. A field was being levelled at the back of St. John's College, when the workmen cut into a Saxon burying-ground. For several days no notice was taken of it; and during that time a number of skeletons and urns (the workmen said several hundreds) had been found and destroyed. As soon, however, as the discovery was made known, steps were taken, with the co-operation of the authorities of St. John's College and Christ's College, the owners and lessees of the land, to have the ground thoroughly examined, under proper supervision, in the interest of the Museum. The excavations occupied more than six weeks, during which time they were never left unwatched. At least thirty skeletons, one hundred urns, and a large quantity of ornaments were discovered. The entire "find" has been placed in the Museum, and forms a most valuable addition to the local Saxon collections.

IN an interesting paper on the Eskimo of Hudson's Strait, reprinted from the Proceedings of the Canadian Institute, Mr. F. F. Payne says that, as a rule, the Eskimo deserve to be called keen observers of Nature. When he was making collections of birds, insects, and plants, he found the natives of great assistance. "If an insect was shown them," he says, "they could usually take me where more of the same species might be found. On the approach of summer they watched with interest its signs, and often would bring to me insects which they believed were the first of the season."

MR. PAYNE found that the Eskimo of Hudson's Strait were much given to the habit of offering food and other things to spirits. By the graves of many of their dead were found scraps of food, tobacco, powder, shot, and other articles, and at first it was supposed that these were offered only to those who had died. To Mr. Payne's surprise, however, a number of like articles were found upon a beacon he had built in the shape of a man. When two cannons, found upon the shore near Cape Prince of Wales, that had undoubtedly been left by some of the early explorers, were made to stand on end, a quantity of bullets, shot, and other rubbish rolled out. On inquiry as to how these things had got there, Mr. Payne was informed they had been given as "an offering to the spirits."

THE extent to which variation may prevail among butterflies is well illustrated in some facts set forth in *The Entomologist* for February, by Mr. W. W. Smith, of Ashburton, New Zealand. The special subject of Mr. Smith's remarks is *Argyrophinga antipodum*, one of the few endemic species of New Zealand Rhopalocera. This butterfly in its season is generally numerous, and owing to its slow and somewhat laboured flight is easily captured. Among the specimens Mr. Smith has taken are some remarkable varieties, exhibiting all the phases or stages of variation to which a single species could be subject. Many individuals of both sexes differ considerably from each other in their ground colouring, the colours of the neuration, and in the number of ocelli. The typical colour of the male is given by Mr. A. G. Butler as "dark greyish brown, paler at base"; in Mr. Smith's specimens every shade of brown is developed, while some are partially melanic forms. Among the females there is also considerable distinction, the general colouring varying from whitish yellow to rich dark orange. In a typical specimen the hind wings are crossed with three small ocelli, the centre one in the male being slightly the largest; among them are several having a broad blackish band crossing the wing from the inner to the outer margin, and inclosing four distinct ocelli. Others have the three ocelli much enlarged and coalescent, while a number possess only two or one ocelli, and in one specimen (a male) they are obsolete on all the wings.

A NEW acid of tin has been obtained by Prof. W. Spring, consisting of two molecules of a higher oxide, SnO_3, combined with one of water. The new acid, $H_2Sn_2O_7$, or $2SnO_3 . H_2O$, is consequently analogous to disulphuric acid, $H_2S_2O_7$, and dichromic acid, $H_2Cr_2O_7$. The method by which Dr. Spring has prepared it is of peculiar interest. A saturated solution of about ten grammes of stannous chloride, in water containing sufficient hydrochloric acid to prevent decomposition into the oxychloride, was treated at the ordinary temperature with excess of peroxide of barium. The latter substance was obtained pure in the form of the hydrate, $BaO_2 . 6H_2O$, by precipitating clear baryta-water with oxygenated water. After the addition of the peroxide the liquid became very thick, and lost most of its limpidity, indicating a change resulting in the production of a colloidal substance. Neither by allowing to stand nor by filtration could any clearing of the solution be effected. But upon subjecting it to dialysis, chloride of barium diffused through the membrane, and was eventually entirely removed by changing the water in which the dialyzer floated every day during a period approaching three months. The contents of the dialyzer were now evaporated as low as possible upon a water-bath; when the evaporation was sufficiently advanced the contents of the dish became converted into a white opalescent jelly, and this eventually dried up into a white solid mass of the new acid. The analyses were most thoroughly carried out, the tin, water, and oxygen each being determined directly, and the numbers obtained are, within the usual limits of error, those required for the $H2Sn_2O_7$. The oxygen was estimated by passing a current of pure hydrogen over a weighed quantity of the substance contained in a porcelain boat heated to redness in a combustion tube. The water obtained was absorbed by calcium chloride, and weighed, and after deducting the water contained in the substance, the oxygen present in the oxide was readily calculated. As a control, the residue of reduced tin was also weighed. These analyses prove beyond doubt that the tin is here present in the form of trioxide, and that at 100° C. one molecule of water remains combined with it. From certain secondary phenomena Dr. Spring is of opinion that the reaction really takes place in two stages; an oxychloride of tin being first formed by direct addition of oxygen to stannous chloride, $SnCl_2 + BaO_2 = SnOCl_2 + BaO$. This stannic oxychloride appears, then, to react with a further molecule of peroxide of barium with production of barium chloride and trioxide of tin, or hyperstannic anhydride, as Dr. Spring terms the new oxide:

$$SnOCl_2 + BaO_2 = BaCl_2 + SnO_3.$$

The baryta obtained as by-product in the first stage is of course dissolved by the hydrochloric acid present, and the barium is thus entirely removed as chloride upon dialysis.

MESSRS. TRÜBNER have in the press a work on ethics, by Mr. S. Alexander, Fellow of Lincoln College, Oxford, entitled "Moral Order and Progress: an Analysis of Ethical Conceptions." It will be in three books: Book I., Preliminary, dealing with conduct and character; Book II., Statical—Moral Order; Book III., Dynamical—Moral Growth and Progress. The work ought to be interesting to students of science, as the author's conclusions, if sound, will tend to confirm the theory of evolution by showing that the characteristic differences of moral action are such as might be expected if that theory were true. In Book III. he aims at proving that moral ideals follow, in their origin and development, the same law as natural species.

THE Clarendon Press has issued a fourth edition of the second volume of Prof. Minchin's "Treatise on Statics, with Applications to Physics." It is to a very great extent a reprint of the previous edition, but Prof. Minchin explains that it treats much more fully of conical angles; contains new articles on line- and surface-integrals and magnetic shells; and presents an improvement in the method of treating some questions of strain and stress, for which the author is indebted to Prof. Williamson.

THE *Annuaire*, for 1889, of the Royal Observatory ot Brussels, by F. Folie, has been published. This is the fifty-sixth annual issue, and the work fully maintains the high standard of excellence attained in previous numbers.

THE first number of a popular scientific periodical—*Der Stein der Weisen*—has just been issued by H. Hartleben, Vienna. It will be published once a fortnight. The editor is A. von Schweiger-Lerchenfeld. If we may judge from the present number, the new periodical is likely to be a decided success. The articles are well written, and there are many illustrations.

MR. S. H. WINTLE contributes to the *Victorian Farmers' Gazette* an account of a mineral substance found in the slightly decayed heart of a beech-tree, *Fagus Cunninghami*, cut down, and split up for firewood, at Gladstone, Mount Camera, Tasmania. A mass of the substance, about one pound in weight, was sent to Mr. Wintle for examination. Analysis proved it to be oxalate of potassium—the "salts of lemon" of commerce. "Potash, as potash," says Mr. Wintle, "enters largely into the composition of vegetable matter. It is to be found in the ashes of all timber and plants in association with lime and soda; but, in this case we find the potash, or more correctly speaking, the oxide of the metal potassium, is in chemical combination with oxalic acid; thus forming a compound salt, highly crystallized. The paradoxical feature of the phenomenon is presented by the query—Where did the oxalic acid come from to combine with the oxide of potassium? Analysis has failed to detect oxalic acid in the wood or leaves of the *Fagus*. There are certain well-known plants which furnish oxalic acid. Notably, the *Oxalis acetocella*, from which it used to be extracted before the great advances of chemistry enabled man to be independent of that plant as its source. Combined with lime it has been found in some lichens, while the roots of rhubarb and bistort contain it in small quantity in combination with potash; but this is the first instance, it seems, of this organic combination being found in a solid, compact, crystallized form, especially in the heart of a tree."

THE fiery sunsets which revealed the existence of the Krakatão dust in the atmosphere were also noticed by Prjevalsky in November and December 1883, as he was crossing the Gobi and the Northern Ala-shan. He describes them as follows in his "Fourth Journey to Central Asia":—"After a bright day, which is here the usual state of the weather during the winter, light cirrus and cirro-stratus clouds appeared in the west, just before sunset, or immediately after. Probably they were floating all day long in the upper strata of the atmosphere, but became visible when the sun went beneath the horizon. Immediately after that, the whole of the western part of the sky became lighted by a bright cream light, which soon acquired a violet colour in the upper parts, with stripes of shadows. At the same time the shadows of the night rose in the east, dark lilac in the lower parts, and violet in the upper parts. The violet colour vanished by and by in the west, and a segment of bright orange colour appeared close by the horizon, on a cream background. Sometimes it acquired a light red colour, but sometimes it became bright red or even blood-red. In the meantime the lilac colour disappeared in the east, and all the sky became of a gray-lilac colour. Amidst the changing colours in the west, Venus glowed like a diamond descending beneath the horizon at the time when the twilight, which lasted for about one hour and a half, came to an end. During nearly all that time the glow in the west was casting shadows, and all objects in the desert appeared in a fantastic light. The sunrise was accompanied by the same phenomena, but in a reverse order: sometimes the morning twilight began with the appearance of a blood-red colour. At full moon the phenomena were less striking, and in the atmosphere of Northern Ala-shan, which is charged with dust, we saw them less often than in the Central and Northern Gobi."

A HUGE Greenland whale, 90 feet in length, after having been seen in various parts of the Cattegat, lately went ashore in the Sound, and was killed. During the previous twenty years a whale had not been seen in these waters. The skeleton is to be forwarded to the Copenhagen Museum.

PROF. O. TORELL AND DR. TRYBOM have petitioned the Swedish Government for funds sufficient to enable them to continue their researches on the sea fisheries of Sweden, and to establish a biological station on the west coast.

LAST summer Dr. Th. Thoroddsen effected some further explorations in the interior of Iceland, visiting parts hitherto untraversed. It is said that in Norse times, in the district west of Hecla, by the River Thjorsaa, a numerous population inhabited a fertile valley, which was laid waste in 1343 by a terrible volcanic eruption of the Raudukambar Mountain. Dr. Thoroddsen now reports that this mountain is not a volcano at all, and that in historical times no volcanic eruption has devastated this valley; but he is of opinion that the colony in question was destroyed through an eruption of Hecla in the middle of the fourteenth century. Dr. Thoroddsen afterwards explored the desert land south of the Hofsjökul, particularly a mountain range, called Kjerlingarfjöll, close to the south of it. These mountains had never been explored before, and Dr. Thoroddsen found a country which he describes as very remarkable. It was known in the low lands that there were some valleys with hot springs, steam having been seen from a distance, but the springs had never been visited. Dr. Thoroddsen found grand sulphur springs in great numbers, which, he states, far excel the well-known ones at Myvain and Krisuvik. There are also numbers of large boiling mud pools—blue, red, yellow, and green in colour—whilst steam penetrates everywhere through fissures in the earth with terrific noise. One steam jet, 6 to 9 feet in height, kept up such a continual roar that it was impossible to hear the loudest shouts for a long distance. Several subterranean cavities were also found containing boiling clay pools, and around one of them the earth trembled far and wide, whilst far down below in the earth a noise was heard like that which might proceed from a gigantic butter-churn. The valleys in which these springs and mud pools are found are surrounded by extensive and deep snow-fields with innumerable fissures, through which the roar of the steam far below the snow can be heard in some places, whilst in others the steam escapes through them. The ground in these valleys is so hot that only with the greatest care is it possible to tread on the thin crust of clay covering the boiling mud below.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Coati (*Nasua rufa* ♀) from Brazil, presented by Mr. N. T. Williams; three Herring Gulls (*Larus argentatus*), British, presented by Mr. L. V. Harcourt; six Moorish Geckos (*Tarentola mauritanica*) from the south of France, presented by Masters F. and O. Warburg; a Thigh-striped Wallaby (*Halmaturus thetidis* ♀) from New South Wales, deposited; a White-throated Capuchin (*Cebus hypoleucus*), a —— Capuchin (*Cebus* sp. inc.) from Central America, purchased; an Eland (*Oreas canna* ♀), a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MULTIPLE STAR ζ CANCRI.—This remarkable stellar system has justly attracted much attention ever since Sir W. Herschel discovered in 1781 that it was really composed of three, not two stars, the principal star being itself a close double. But the interest with which the system was regarded was greatly increased by the remarkable paper which Prof. O. Struve produced upon the subject, and communicated to the Paris Academy of Sciences in 1874 (*Comptes rendus*, vol. lxxix. p. 1463), and in which he pointed out a noteworthy inequality in the motion of the distant companion C, having a period of about twenty years. The question was again taken up by Prof. Hugo Seeliger in 1881, in a paper entitled "Ueber die Bewegungverhältnisse in dem dreifachen Sternsystem ζ Cancri," and presented to the Vienna Academy of Sciences on May 5 of that year. Prof. Seeliger has continued his discussion of the observations of the star, and has recently published a further paper on the subject, which appears in the Memoirs of the Royal Bavarian Academy of Sciences, Munich, under the title "Fortgesetzte Untersuchungun ueber das mehrfache Sternsystem ζ Cancri." The result of his further labours has been in effect to confirm the results he had obtained in his earlier work, and those which Prof. Struve had brought out in 1874.

The three stars A, B, and C, have the magnitudes respectively 5·0, 5·7, and 5·3. The proper motion of the system amounts in a century to + 10″·6 in R. A., and to − 11″ in Decl. The close pair, A and B, first separated by Herschel, have a motion round one another in about sixty years, their apparent distance from each other varying from about 0″·6 to 1″·1; whilst C, the more distant companion, has moved through about 55° of position-angle round the other two since Herschel's observation in 1781, its distance never very greatly varying from $5\frac{1}{2}''$. The motion of A and B round their common centre of gravity does not appear to be disturbed to any appreciable extent by the influence of C, which is so placed as not to affect their apparent relative motions, even though a very considerable mass be assigned to it, and as a fact Prof. Seeliger finds, for the most probable value of the mass of C, $\frac{m'}{1 + m} = 2{\cdot}386$, where 1, m, and m' are the masses of A, B, and C respectively. But there is a periodical retrogression of C itself which is most easily accounted for by supposing the presence of a close companion, one hitherto undetected, and therefore either entirely dark, or but faintly luminous. The distance of this companion is probably only a few tenths of a second, the distance of C from the point, S_2, round which it appears to revolve, and which may be reasonably assumed to be the centre of gravity of itself and of D, the as yet undiscovered fourth member of the family, being only about one-fifth of a second.

The entire group therefore may be considered as a double-double, the following being the definitive elements derived for the two pairs:—

	For A and B.		For C about S_2.
T ...	1868·112		... ... 1860·127
☊ ...	109°·735	1850·0	... ... 71°·958
λ ...	80·190	1850·0	... ... 109·677
i ...	11·135	1850·0	... ... 17·352
e ...			... ... 0·1106
a ...	0″·853		... ... 0″·217
φ ...	22·450		... ...
n ...	− 6·0898		.. ... − 20·460

For the motion of S_2 round the optical centre of A and B:—

$$\rho_0' = 5''{\cdot}438.$$
$$p_0 = 145^\circ{\cdot}46 - 0^\circ{\cdot}513\,(t - 1850{\cdot}2).$$

The concluding portion of this valuable contribution to the study of a most interesting case in stellar physics is devoted to the consideration of personal errors in the observations, and a plate is added giving a graphical representation of the apparent motion of C, and bringing out in a striking manner the evidence the observations afford of the looping of the curve.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *FEBRUARY* 24—*MARCH* 2.

(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 February 24

Sun rises, 6h. 57m.; souths, 12h. 13m. 21·5s.; sets, 17h. 30m.: right asc. on meridian, 22h. 31·6m.; decl. 9° 16′ S. Sidereal Time at Sunset, 3h. 49m.

Moon (New on March 1, 22h.) rises, 2h. 59m.; souths, 7h. 13m.; sets, 11h. 23m.: right asc. on meridian, 17h. 30·3m.; decl. 20° 54′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	6 5 ...	11 2 ...	15 59 ...	21 19·9 ...	12 49 S.
Venus ...	8 2 ...	15 2 ...	22 2 ...	1 20·3 ...	11 1 N.
Mars ...	7 49 ...	14 2 ...	20 15 ...	0 21·1 ...	1 46 N.
Jupiter ...	4 1 ...	7 56 ...	11 51 ...	18 13·8 ...	23 5 S.
Saturn ...	15 17 ...	22 53 ...	6 29* ...	9 12·8 ...	17 21 N.
Uranus ...	21 40* ...	3 4 ...	8 28 ...	13 20·8 ...	7 49 S.
Neptune..	9 49 ..	17 32 ...	1 15* ...	3 51·1 ...	18 27 N.

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

Feb.	h.	
25 ...	1 ...	Jupiter in conjunction with and 1° 11′ south of the Moon.
27 ...	5 ...	Mercury stationary.
28 ...	2 ...	Mercury in conjunction with and 4° 18′ north of the Moon.

Meteor-Showers.

	R.A. °	Decl.	
Near β Trianguli	30 ...	35 N.	
,, δ Virginis	192 ...	2 N.	
,, α Serpentis	235 ...	10 N. ...	Swift; streaks.
	280 ...	17 S. ...	Very swift.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5 ...	81 17 N. ...	Feb. 27,	18 28	m
T Arietis	2 42·1 ...	17 3 N. ...	,, 27,		M
Algol	3 1·0 ...	40 32 N. ...	,, 28,	5 52	m
R Geminorum ...	7 0·7 ...	22 53 N. ...	,, 26,		m
R Canis Majoris ...	7 14·5 ...	16 11 N. ...	,, 25,	1 30	m
			and at intervals of	27 16	
T Geminorum ...	7 42·6 ...	24 1 N. ...	Mar. 1,		M
U Virginis	12 45·5 ...	6 10 N. ...	,, 2,		M
U Coronæ	15 13·7 ...	32 3 N. ...	Feb. 25,	5 8	m
X Cygni	20 39·0 ...	35 11 N. ...	,, 28,	2 0	m
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	Mar. 2,	0 0	m
Y Cygni	20 47·6 ...	34 14 N. ...	Feb. 24,	17 40	m
			,, 27,	17 40	m
δ Cephei	22 25·0 ...	57 51 N. ...	,, 28,	3 0	m

M signifies maximum; m minimum.

GEOGRAPHICAL NOTES.

AN Antarctic Expedition is being again talked of. A New Zealand colonist (of Norwegian origin) has come to Europe for the purpose of taking out a contingent of his countrymen accustomed to fishing. His object is to endeavour to organize an Antarctic whale fishery. He hopes to equip two steamers with which to explore the region generally, and, if possible, he will leave a contingent of men on Victoria Land, or some other suitable point, for a whole year. One or more scientific men will be taken, so that if the proposed expedition be carried out we may expect some important results.

DR. HUGO ZÖLLER (sent out by the *Kölnische Zeitung*) has been doing some original exploring work in German New Guinea. He made an excursion for a considerable distance into the interior. In November last he ascended the Finisterre Mountains to a height of 9000 feet. Some of the peaks in this and the Bismarck Ranges rise to a height of over 10,000 feet.

CAPTAIN PAGE, who recently read a paper on the Gran Chaco at the Royal Geographical Society, proceeds shortly to the Argentine Republic for the purpose of thoroughly exploring the Pilcomayo. He will probably be accompanied by a naturalist.

THE French are endeavouring to raise the funds for a Congo railway which will pass entirely through French territory, in opposition to the scheme for a railway from Vivi to Stanley Pool, for which a survey has recently been made by Belgian engineers. The French railway would run from Brazzaville, on the north side of Stanley Pool, to the River Kwilu, 100 kilometres. Steps, it is stated, will be taken to render the Kwilu navigable, and so establish direct communication between the Congo and the Atlantic.

IN a long article in the new number of the *Mouvement Géographique*, the question of the origin and course of the Lomami, one of the great southern tributaries of the Congo, is discussed. The conclusion is that it is the same river which Cameron crossed far to the south, and which has been crossed at various points further northwards. It enters the Congo some distance below Stanley Falls. Its course is probably about 1000 miles in length.

DR. OSCAR BAUMANN contributes to the February number of *Petermann's Metteilungen* a short monograph (with map) on the district of Usambara, in East Africa. The monograph ought to be specially interesting to geologists.

THE February number of the *Scottish Geographical Magazine* contains several very useful articles. Colonel Cadell, Chief Commissioner of the Andaman Islands, gives a highly interesting account of the group, and especially of its people, who, he maintains, have been very much maligned from the days of Marco Polo downwards. The people are fast dying out. Dr. Guppy sends a preliminary note on the geological structure of the Sindang-Barang district on the south coast of Java. Dr. Guppy sums up the structure of the sea-coast of this part of Java as follows: a basis of massive volcanic rocks overlain by submarine tuffs and volcanic muds as far as twelve miles from the coast, and by older and allied tuffs farther inland. The upheaval in post-Tertiary times has been very great, and can only be measured by several thousands of feet. Mr. S. P. Ford gives a brief *résumé* of our knowledge of the geography of the Transvaal; and Mr. W. A. Taylor supplies a real want in his account of the Philppine Islands, compiled from various recent sources.

NOTES ON METEORITES.[1]

VIII.

THERE can be little doubt that it is to the varying conditions produced by the outflows in both directions along the radius vector, to which reference was made in the last article, that the various appearances put on by the axis of comets' tails are due. Thus, in Coggia's comet, to take an instance, the perihelion passage of which took place on August 27, on June 10 the axis was brighter than the rest of the tail, but by July 10 the bright axis was replaced by one of marvellous blackness, which was one of the features of the comet at that time, and this dark axis expanded as perihelion was approached.

The tail is always curved, but if the earth lie in the plane of the orbit the curvature cannot be seen.

FIG. 27.—Great comet of 1861, seen on June 30, when the earth was in the plane of the orbit.

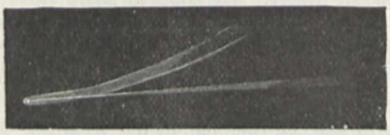


FIG. 28.—Same comet seen on June 15.

The accompanying woodcuts will explain how the solar repulsion produces this curvature, and how the curvature will depend upon the velocity due to repulsion.

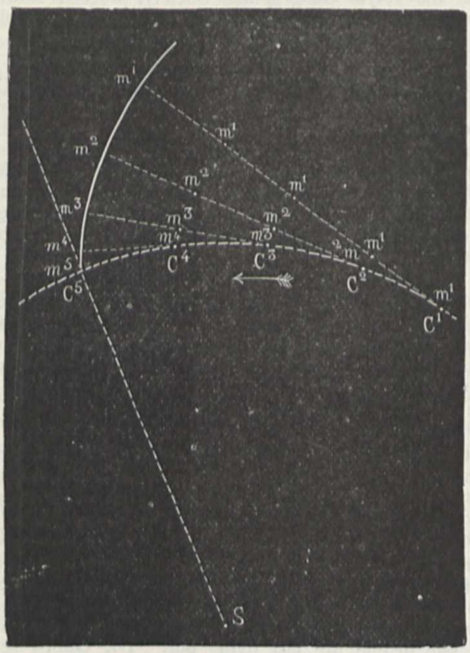


FIG. 29.—Slight repulsion ; great curvature.

Fig. 29, which I owe to M. Faye,[2] represents the successive positions of a series of molecules emitted by the nucleus of a comet so as to constitute the axis of the tail. A density is imagined such that the repulsive force exactly counterbalances the solar attraction: thus their motion, solely due to the tangential velocity of the comet, takes place in a straight line. To again simplify matters, this rate is supposed constant, as if the orbit were a circle.

On the first day, the comet being at C^1, a molecule m^1 is detached and subsequently follows the line $m^1\ m^1\ m^1$. On the second day, a molecule m^2, likewise leaves the nucleus at C^2, and subsequently describes the tangent $m^2\ m^2\ m^2$. Similarly, on the third day, for a molecule m^3 ; and so on. If we join by a continuous line the series of positions occupied at the same time, the fifth day, by all these molecules, m^5, m^4, m^3, m^2, m^1, we shall have the curvilinear axis of the tail ; this will be, in this particular case, the involute of a circle. This construction accounts for the three laws which have been ascertained as the result of observation : (1) the tail, at its origin, is sensibly opposed to the sun, S ; (2) the tail is curved backwards on its path ; (3) the axis of the tail is a plane curve situated in the plane of the orbit.

If the density of these molecules were still smaller, the repulsive force would prevail over the solar attraction, and the molecules would describe no longer straight lines, but sections of an hyperbola whose convexity would be turned towards their common focus, S (see Fig. 30).

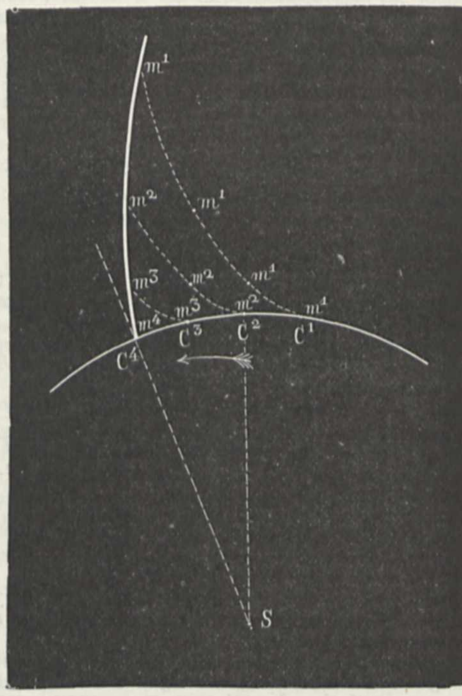


FIG. 30.—Here the velocity is greater and the tail is straighter.

The series of points m^1, m^2, m^3, m^4, emitted at C^1, C^2, C^3, C^4, by the comet, gives a curve like the former one, but with a curvature much less pronounced and nearer to the radius vector.

Now the single tail we have been considering will depend upon the repulsive action upon molecules of similar density, and that very small.

But suppose there are in consequence of collisions among the members of the swarm, several gases given off which can retain their gaseous form, and suppose they are of different densities. Then it is evident that a winnowing process will be set up, and that the molecules of smallest density will be repelled with the highest velocity ; and given these varying densities, we must get more tails than one—one, in fact, for each representative density.

M. Bredichin, of the Moscow Observatory, has in fact shown that there are three distinct types of tails. In the first class, the tails are long and straight, and the repellent energy of the sun upon the small particles is about twelve times as great as the energy of his gravitational attraction. The particles therefore leave the nucleus with a high velocity, generally about fourteen or fifteen thousand feet per second. The greater this velocity in relation to the rate of travel of the comet, the straighter of course will be the tail, because the particles forming it do not lag behind. In the second type, the energies of the

[1] Continued from p. 236.
[2] "Forms of Comets," NATURE, vol. x. p. 268.

attraction and repulsion balance each other, or nearly so, and the tails of this class are plumy and gently curved. In this case the particles which go to form the tail leave the head with a velocity of about 3000 feet per second. Tails of the third type are short and strongly bent, the repellent energy being only about one-fifth of the attractive energy of the sun, and the velocity of the particles leaving the head is only about 1000 feet per second.

Many comets exhibit tails of more than one type, and it was conjectured long ago that such tails were composed of different kinds of matter.

Bredichin went further, and defined the composition of the different kinds of tails which he had classified, by referring to the molecular weights of the materials which would give the relative values of the repulsive and attractive forces necessary for tails of the different types. He thus found that the long straight tails of the first type would be probably formed by hydrogen, since this substance, on account of its exceeding lightness, would be little influenced by gravity, while at the same time strongly influenced by the solar repulsion. The second type of tails he considered to be made of hydrocarbons, since hydrocarbons have a molecular weight such that the repellent and attractive forces of the sun upon their particles may be nearly equal. Iron, on the other hand, would be more subject to the action of gravity, on account of its greater weight, and was therefore taken as adapted to tails of the third type.

There is nothing extravagant in these suppositions, for we know that all the substances in question do exist in comets, and it is evident that much is to be learnt from a continuation of the inquiry, but at the outset we can see that iron vapour cannot in space remain as vapour to form a tail.

We know perfectly well that the short-period comets get less brilliant with every approach to perihelion, and that some do not even throw out a tail, and we can easily ascribe both these results to the fact that after several such appulses the vapours liable to be driven out of the meteorites by temperature get less and less.

If this be so, we may regard a comet with many tails as one which for the first time undergoes perihelion conditions.

If it be conceded that the tails of comets are in part composed of hydrogen and compounds of carbon with gases such as oxygen, an explanation seems to be suggested of many recorded phenomena, while at the same time it seems more probable that the repulsive force would act continuously upon permanent gases rather than on condensable vapours, such as iron vapour, to take an instance.

Suppose that the sun has been formed by the coming together of meteors, whether brought by comets or not, it is obvious that with equal temperatures *of the sun* the repellent action would be the same on the permanent gases given off by the meteorites, whether in large or small groups. In the larger groups there would be possibly more collisions, and therefore greater possibilities of higher temperature *of the meteorites*.

This action would surround the sun, as it were, by a cordon, inside which, to take instances, neither hydrogen nor oxycarbon-compounds could enter. Hence we should have a sun without hydrogen, carbon, or oxygen.

But while, as demanded on this view, the quantity of carbon and oxygen is extremely small, even if the latter exists at all, the quantity of hydrogen is enormous.

This difference can, however, be accounted for by the idea which has been suggested on several other grounds, that the hydrogen which plays such an important part in the sun's economy and in the economy of all stars hotter than the sun is really produced locally by the dissociation of the vapours of the chemical elements which form the sun and the meteoritic constituents which still reach it in the shape probably of iron and silicates.

We know perfectly well (from Dunér's work chiefly, in stars of the class III.*b*) that when the sun gets cooler its atmosphere will consist almost exclusively of carbon compounds; and indeed one of the last scenes in the drama of world-formation seems to be the gradual approach of the "cordon" to which I have referred, as the radiant energy of the star is diminished, thereby enabling all the permanent gases in the system to gradually approach the primary; and it is not impossible that the great differences of density of the interior and exterior planets may be connected with this state of things.

Before passing on, it is well to recur to the question, Why should not *vapours* be also repelled from the cometary nucleus and its envelopes?

No doubt they are; but it is straining the facts to suppose that they would not be condensed by the cold of space before they had been repelled any great distance; the enormous lengths of some comets' tails would seem to negative any such possibility.

Some of these lengths may be given in miles:—

Comet	1843 (I.)	198,800,000 miles
,,	1680	149,000,000 ,,
,,	1847 (I.)	130,800,000 ,,
,,	1811 (I.)	109,400,000 ,,
,,	1860 (III.)... ...	21,700,000 ,,

With regard to the rate at which the tails are thrown out it may be stated that, in the case of Donati's comet, between September 23 and October 10 the tail had increased from 15,000,000 to 55,000,000 miles, or, speaking roughly, the tail had increased by 2,000,000 miles a day.

If we are justified in considering that the materials of the comet thus repelled to form the tail are non-condensable gases, such as the hydrogen and the carbon compounds which are actually found in meteorites, we have in this fact probably the *vera causa* of the so-called occlusion of these gases by meteorites. That is, one set of meteorites—a comet—may be giving off these gases, while other meteorites, which have never been members of such a large swarm, may occupy regions of space swept over by the gases repelled from the comet.

But if it be agreed that it is not probable that, say, the vapours of iron and magnesium could retain their vaporous condition so long as the hydrogen and the carbon compounds—there can be no doubt that they start on the common journey in consequence of the repulsive action outside the track of the comet—then we shall expect to find condensed particles of iron, nickel-iron, and magnesium or their compounds; and here again we have a *vera causa* for the chondrites which enter so largely into the composition of meteorites.

The tail of a comet being thus formed at the expense of the materials composing the head, the materials removed from the head can never be returned to it because of its insufficient gravitational power over them, and moreover they can no longer traverse the same orbit as the comet to which they originally belonged, because they have already been turned out of that course by the forces attending the development of the tail. The small tail-forming meteoric bodies thus become distributed throughout the space occupied by our system, and give no further trace of their existence, unless they happen to break into our atmosphere and appear as shooting-stars.

Comets must thus degenerate, so far at all events as their easily volatilized constituents are concerned, with each perihelion passage, but as the majority of them only approach the sun at long intervals of time they do not suffer much in this way. Some of the short-period comets get less and less brilliant at each successive perihelion passage, and others are then observed entirely without tails, all the available tail-forming material having been used up and dispersed into space.

It is a fact well worthy of consideration that on many occasions pulsations exactly resembling those observed in auroræ have been observed in comets' tails.

This subject is thus referred to in Guillemin's book on comets:—

"Kepler is the first observer who has made mention of the changes. 'Those,' he says, 'who have observed with some degree of attention the comet of 1607 (an apparition of Halley's comet) will bear witness that the tail, short at first, became long in the twinkling of an eye.' Several astronomers—Kepler, Wendelinus, and Snell—saw, in the comet of 1618, jets of light, coruscations, and marked undulations. According to Father Cysatus, the tail appeared as if agitated by the wind; the rays of the coma seemed to dart forth from the head and instantly return again. Similar movements were observed by Hevelius in the tails of the comets of 1652 and 1661; and Pingré, describing the observations of the comet of 1769, made at sea, between August 27 and September 16, by La Nux, Fleurien, and himself, thus describes the phenomenon of which he was a witness:—'I believe that I very distinctly saw, especially on September 4, undulations in the tail similar to those which may be seen in aurora borealis.' The stars which I had seen decidedly included within the tail were shortly after sensibly distant from it.

"M. Liais has given the following account of the observations made by him of the great comet of 1860:—'On the evening of July 5, whilst I was observing the comet at sea, I saw a rather intense light from time to time arise in those portions of the tail that were furthest from the nucleus. Sometimes instantaneous, and appearing upon a small extension of the extremity of the tail, which then became more visible, the fugitive gleams reminded me of the pulsations of the aurora borealis. At other times they were less fleeting, and their propagation in rapid succession could be followed for some seconds in the direction of the nucleus near the extremity of the tail. These appearances then resembled the progressive undulations of the aurora borealis, but even in this case they were only visible in the last third of the length of the tail. The gleams in question were similar to those that I remember to have seen in the tail of the great comet of 1843, and which were observed by very many astronomers.'"

The American observers of Donati's comet in 1868 described a number of brighter bands "like auroral streamers" crossing the tail and diverging from a point between the nucleus and the sun.[1]

This point is one well worthy of subsequent inquiry. I have brought together evidence to show that in the aurora one of the chief factors in the production of the spectrum is meteoric dust.

If this be conceded, we have meteoric dust in all probability very slowly falling through our atmosphere at a height at which its pressure is very low, the luminosity both of the dust and the atmosphere being produced by electricity. Whether the electricity is produced by the movement is a matter on which at present we are quite ignorant, but if it be eventually shown that all auroræ follow well-recognized star-showers a certain amount of plausibility will be accorded to the notion.

However this may be, we must in the case of the aurora regard the permanent gases in the air as a constant, and the dust as the variable.

But if we wish to assimilate these displays with comets' tails, we must in the latter case consider meteorites in space as the constant, and the permanent gases repelled from the comet as the variable.

Prof. Tait, assuming that the head of a comet is a swarm of meteorites or stones, varying in size from a marble to boulders 20 or 30 feet in diameter, has shown that all the various cometary phenomena may be explained. His researches have not yet been printed *in extenso*, but the following general statement gives a summary of the results of his calculations which appeared in *Good Words* some time ago.

Firstly, with regard to the masses of the comets. The total mass of a comet cannot be very great, for, as we have seen, no measurable disturbance of planetary orbits has been known to be produced, and this small mass is just as likely to be due to scattered solid masses as to one continuous gaseous mass, and indeed we know that this is so. In the case of comets of but small masses, the component meteorites would be small and far apart. Then with regard to the transparency of the comet, it is calculated that a meteorite 25 feet in diameter at a distance of half a million miles from us could not totally eclipse a star of the same size as our sun, even if it were at such a distance as to be barely visible to the naked eye. Again, if some of the meteorites were large enough to eclipse the stars behind the comet, the eclipse would be of very brief duration, and we should see the star as if nothing had happened. In order for the comet to reduce the light of a star seen through it by one-tenth, it would require to be 300 miles thick, supposing the stones to be 1 inch cube and 20 feet apart.

While the swarm which builds up the comet is coursing round the sun as a whole, the individual members will themselves gravitate towards each other; and if we suppose the whole mass to be 1/1000 that of the earth, and the meteorites to be uniformly distributed in a sphere 20,000 miles in diameter, those coming from the outside to the centre of the group would have a velocity of about 500 feet per second. The stones colliding will generate heat, and some gas will be evolved; some members of the mass will be quickened, while other constituents of the mass will be retarded in their motion, and in this way we have a probably sufficient explanation of the various forms which the telescope has revealed to us. And then finally Prof. Tait goes on to show that the result of these collisions would be such a smashing up of the constituents of the swarm that much finely-attenuated material would be left behind, sufficient to reflect sunlight, and to give rise to the phenomena of the tail.

[1] Webb, p. 197.

If in the imaginary swarm the mass of each stone be 100 pounds, and its velocity, due to attraction, be 500 feet per second, the heat resulting from the impact of two of them would be quite sufficient to volatilize a portion, and to make the outsides of the stones white-hot. Stones of this weight would be about 10 inches cube, and in the swarm considered there would therefore be about 136,000,000,000,000,000,000 of them. At the rate of one collision per second, there being about 31,436,000 seconds in a year, there would be a possibility of one collision per second for 2,150,000,000,000 years. There would therefore be material for such collisions for a period of over two million years even at the extravagant rate of one million per second, and on the assumption that no stone comes into collision with another more than once.

The whole mass being 1/1000 that of the earth, and the space occupied being 250 times that occupied by the earth, the stones in question being 10 inches cube will only occupy about 1/8000 of the space through which they are distributed; the average distance apart would be about 17 feet. The swarm would reflect about half as much sunlight as a slab of the same material in the same place, but it would probably be too opaque to transmit starlight. By making the stones larger, and thus increasing the distances between them, the luminosity would be retained, while at the same time the swarm would be sufficiently transparent. It thus seems to suit the hypothesis better if we regard the separate stones to be greater than 10 inches cube.

J. NORMAN LOCKYER.

(To be continued.)

THE FORCES OF ELECTRIC OSCILLATIONS TREATED ACCORDING TO MAXWELL'S THEORY. BY DR. H. HERTZ.[1]

I.

Note by the Translator.

THE early part of the following paper is no doubt familiar to the more important persons in this country, and therefore need perhaps hardly have been translated. Nevertheless, as these experiments of Hertz form a sort of apotheosis of Maxwell's theory, it is natural to reproduce this portion as well as the rest; and inasmuch as Hertz did not at first express his discoveries in Maxwellian language, it is interesting to see how he regards the matter since his conversion, and how he now presents his ideas to foreigners.

I have translated the paper because it seems to me a remarkable example of clear theoretic insight in conjunction with great experimental skill, because it is pleasantly written, and because it deals in a powerful manner with a profoundly interesting subject.

I can hardly hope to have escaped errors in translating, but the original paper in *Wiedemann's Annalen* for January of this year is very accessible. OLIVER J. LODGE.

The results of the experiments on quick electric oscillation which I have carried out appear to me to lend to Maxwell's theory of electrodynamics an ascendancy over all others. At first I interpreted these experiments in terms of older notions, seeking to explain the phenomena in part by means of the co-operation of electrostatic and electro-magnetic forces. To Maxwell's theory in its pure development such a distinction is foreign. I wish, therefore, now to show that the phenomena can also be explained in terms of Maxwell's theory without any such distinction. If this attempt succeeds, questions about special propagation of electrostatic force, being meaningless in Maxwell's theory, are at once settled. And besides this special aim, a closer insight into the play of forces concerned in rectilinear oscillations is not without interest.

The Formulæ.

In what follows we have only to concern ourselves with forces in free ether. Let X, Y, Z, be the components of electric force acting on the points x, y, z; let L, M, N be the corresponding components of magnetic force; let t be the time, and let A stand for $\sqrt{(\mu K)}$. Then, according to Maxwell, the time-rate of change of the forces is dependent on their distribution in space in the following way:—

[1] Translated and communicated by Dr. Oliver Lodge.

$$A\frac{dL}{dt} = \frac{dZ}{dy} - \frac{dY}{dz}$$
$$A\frac{dM}{dt} = \frac{dX}{dz} - \frac{dZ}{dx} \quad \cdots\cdots (1)$$
$$A\frac{dN}{dt} = \frac{dY}{dx} - \frac{dX}{dy}$$

$$A\frac{dX}{dt} = \frac{dM}{dz} - \frac{dN}{dy}$$
$$A\frac{dY}{dt} = \frac{dN}{dx} - \frac{dL}{dz} \quad \cdots\cdots (2)$$
$$A\frac{dZ}{dt} = \frac{dL}{dy} - \frac{dM}{dx}$$

Originally, and therefore always, the following conditions must be satisfied:

$$\frac{dL}{dx} + \frac{dM}{dy} + \frac{dN}{dz} = 0, \text{ and } \frac{dX}{dx} + \frac{dY}{dy} + \frac{dZ}{dz} = 0 \quad . \quad . \; (3)$$

The electric energy contained in a portion of ether of volume τ is—

$$\frac{1}{8\pi}\int(X^2 + Y^2 + Z^2)\,d\tau;$$

the magnetic energy is—

$$\frac{1}{8\pi}\int(L^2 + M^2 + N^2)\,d\tau;$$

the integration extending all through the volume. The total energy is the sum of both these portions.

These expressions form the essential ingredients of Maxwell's theory as it relates to the ether. Maxwell arrived at them by forsaking action at a distance, and by accommodating the ether with the properties of a highly dielectric medium. One can also get the same equations in another way. But hitherto no direct proof of the validity of these equations has been afforded by experience. It appears most logical, therefore, to regard them independently of any way in which they may have been arrived at, to consider them as hypothetical assumptions, and to let their probability depend upon the very great number of legitimate conclusions which they embrace. Taking this point of view, one can do without a series of auxiliary ideas, which render the understanding of Maxwell's theory more difficult, even if on no other ground than that, so soon as one finally excludes the hypothesis of immediate action at a distance, these notions possess no meaning.

Multiply equations (1) by L, M, N, and (2) by X, Y, Z; add the equations together, and integrate over the whole space, whose volume element is $d\tau$, and whose surface element is dS; we get—

$$\frac{d}{dt}\left\{E_e + E_m\right\}$$
$$= \frac{1}{4\pi A}\int\{(NY - MZ)\lambda + (LZ - NX)\mu + (MX - LY)\nu\}\,dS,$$

where λ, μ, ν are the direction-cosines of the normal to the surface.

This equation shows that the amount by which the energy of the space has increased can be regarded as having entered through its walls. The quantity entering through any single element of surface is equal to the product of the components of the electric and magnetic forces which belong to that element, multiplied by the sine of the angle between them, and divided by $4\pi A$. On this result it is well known that Prof. Poynting has founded a remarkable theory on the transfer of energy in the electro-magnetic field.

For the purpose of solving the equation, we limit ourselves to the special but important case where the distribution of the electric force is symmetrical about the axis of z, and hence that this force is absent at every point of the meridian planes intersecting in the axis of z, and only depends on the z co-ordinate of a point, and on its distance, $r = \sqrt{x^2 + y^2}$, from the z axis. We will denote the electric force in the direction of r, namely, $X\frac{x}{r} + Y\frac{y}{r}$, by R; and the component of the magnetic force which is normal to the meridian planes, viz. $L\frac{y}{r} - M\frac{y}{r}$, by P. We assert further that if Π is any function of r, z, and t, which satisfies the equation—

$$A^2\frac{d^2\Pi}{dt^2} = \nabla\Pi;$$

and if we put $Q = r\frac{d\Pi}{dr}$, the following is a possible solution of our equations:—

$$Z = \frac{1}{r}\frac{dQ}{dr},$$
$$R = -\frac{1}{r}\frac{dQ}{dz},$$
$$P = \frac{A}{r}\frac{dQ}{dt},$$
$$N = 0.$$

To prove this assertion we observe that

$$X = R\frac{dr}{dx} = -\frac{d^2\Pi}{dx\,dz},$$
$$Y = R\frac{dr}{dy} = -\frac{d^2\Pi}{dy\,dz},$$
$$Z = \frac{1}{r}\frac{d}{dr}\left(r\frac{d\Pi}{dr}\right) = \frac{d^2\Pi}{dx^2} + \frac{d^2\Pi}{dy^2},$$
$$L = P\frac{dr}{dy} = A\frac{d^2\Pi}{dy\,dt},$$
$$M = -P\frac{dr}{dx} = -A\frac{d^2\Pi}{dx\,dt},$$
$$N = 0.$$

One has only to insert these expressions into equations (1), (2), (3), to find equations (2) and (3) identically satisfied, and (1) also if we have regard to the differential equation for Π.

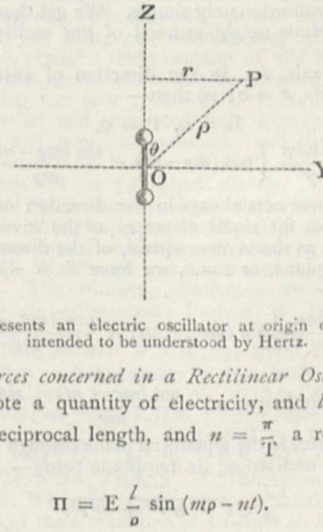
It may be mentioned that also inversely, neglecting certain practically unimportant limitations, every possible distribution of electric force which is symmetrical to the axis of z can be represented in the above form, but it is not necessary for the sequel to substantiate this assertion.

The function Q is of importance. The lines in which the surface of rotation Q = const. cut the meridian planes are the lines of electric force; the construction of the same for one meridian plane furnishes at every instant an immediate presentation of the force distribution.

If we cut the shell between Q and Q + dQ by a surface of rotation round the axis of z, the product of electric force and surface which Maxwell calls the "induction" is for every such surface the same. If we arrange the system of surfaces Q = const. in such a way that Q increases in arithmetic progression, the same statement remains true when we compare the sections of the different shells with one another.

In the plane diagram which consists of sections of the meridian plane with the equidistant surfaces Q = constant, the electric force is inversely proportional to the normal distance of consecutive lines Q = const. only for the case when points compared lie at the same distance from the axis of z. In general the rule is that the force is inversely proportional to the product of this distance and of the co-ordinate r of the point considered.

If we introduce polar co-ordinates ρ and θ they will be like this.



The figure represents an electric oscillator at origin of co-ordinates as intended to be understood by Hertz.

The Forces concerned in a Rectilinear Oscillation.

Let E denote a quantity of electricity, and l a length; let $m = \frac{\pi}{\lambda}$ be a reciprocal length, and $n = \frac{\pi}{T}$ a reciprocal time; and let us put

$$\Pi = E\frac{l}{\rho}\sin(m\rho - nt).$$

This value satisfies the equation—

$$A^2 \frac{d^2\Pi}{dt^2} = \nabla\Pi,$$

so soon as we settle that,

$$\frac{m}{n} = \frac{T}{\lambda} = A,$$

and $\frac{\lambda}{T}$ will be the velocity of light. And, indeed, the introduced equation is satisfied everywhere, except at the origin.

In order to find out what electrical processes are set up by the distribution of forces specified by Π, we investigate its immediate surroundings.

We put ρ vanishing in comparison with λ, and neglect *mρ* in comparison with *nt*.

Then—

$$\Pi = E\frac{l}{\rho} \sin nt.$$

Since, now—

$$\left(\frac{d^2}{dx^2} + \frac{d^2}{dy^2}\right)\frac{1}{\rho} = -\frac{d^2}{dz^2}\left(\frac{1}{\rho}\right),$$

we have—

$$X = -\frac{d^2\Pi}{dxdz},\ Y = -\frac{d^2\Pi}{dydz},\ Z = -\frac{d^2\Pi}{dzdz}.$$

So the electric forces appear as the derivative of a potential—

$$\phi = \frac{d\Pi}{dz} = El \sin nt \,.\, \frac{d}{dz}\left(\frac{1}{\rho}\right);$$

and this expresses an electrical [*Doppelpunkt*, by which I suppose is meant either an involution or a spherical harmonic] whose axis coincides with the *z* axis, and whose moment oscillates between the extreme values E*l* and − E*l* with the period T.

Our force distribution, therefore, represents the action of a rectilinear oscillator which has the very small length *l*, and on whose poles at the maximum the quantities of electricity ± E are free.

The magnetic force perpendicular to the direction of the oscillator is, in the immediate neighbourhood,

$$P = -AEln \cos nt \frac{\sin\theta}{\rho^2}.$$

According to the Biot-Savart law, this is the force of a current element in the direction of the axis of *z*, of length *l*, whose intensity, magnetically measured, oscillates between the extreme values $\pm \frac{\pi AE}{T}$. In fact the motion of the electricity E corresponds to a current of that magnitude.

From Π we get—

$$Q = Elm\left\{\cos(m\rho - nt) - \frac{\sin(m\rho - nt)}{m\rho}\right\}\sin^2\theta,$$

and from this the forces Z, R, P follow by differentiation.

The formulæ are too complicated for it to be possible to obtain immediately from them in their general form a representation of the distribution of the forces. For some special cases the results are meanwhile proportionately simple. We get these at once—

(1) The immediate neighbourhood of the oscillator we have already treated.

(2) In the *z* axis, *i.e.* in the direction of swing, we have $dr = \rho d\theta$, $dz = d\rho$, $\theta = 0$; so then—

$$R = 0,\ P = 0,$$

$$Z = \frac{2Elm}{\rho^2}\left\{\cos(m\rho - nt) - \frac{\sin(m\rho - nt)}{m\rho}\right\}.$$

The electric force acts always in the direction of the oscillator; it diminishes for small distances as the inverse cube, for greater distances as the inverse square, of the distance.

(3) In the *xy* plane, or $z = 0$, we have $dz = -\rho d\theta$, $d\rho = dr$, $\theta = 90$, and so—

$$P = \frac{AElmn}{r}\left\{\sin(mr - nt) + \frac{\cos(mr - nt)}{mr}\right\}$$

$$R = 0,$$

$$Z = \frac{Elm^2}{r}\left\{-\sin(mr - nt) - \frac{\cos(mr - nt)}{mr} + \frac{\sin mr - nt)}{m^2r^2}\right\}.$$

The electric force in the equatorial plane through the oscillator is parallel to the oscillation, its amplitude being—

$$\frac{El}{r^3}\sqrt{1 - m^2r^2 + m^4r^4}.$$

The force decreases with distance, at first quickly as the inverse cube, later only slowly, and inversely as the distance itself. At great distances the action of the oscillator can only be noticed in the equatorial plane, not in the axis itself.

(4) At very great distances we can neglect higher powers of $1/\rho$, compared with lower ones. So we get at such distances—

$$Q = Elm \cos(m\rho - nt)\sin^2\theta,$$

whence—

$$P = A\frac{Elmn}{\rho}\sin(m\rho - nt)\sin\theta,$$

$$Z = -\frac{Elm^2}{\rho}\sin(m\rho - nt)\sin^2\theta,$$

$$R = \frac{Elm^2}{\rho}\sin(m\rho - nt)\sin\theta\cos\theta.$$

Thence follows—

$$Z\cos\theta + R\sin\theta = 0.$$

The direction of the force is therefore at great distances everywhere normal to the radius vector from the origin of force; the spreading out occurs in pure transverse waves. The magnitude of the force is equal to $\frac{Elm^2}{\rho}\sin(m\rho - nt)\sin\theta$, and decreases at a constant distance from the origin towards either axis, being proportional to the distance from this latter.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A Report on the new Chemical Laboratory states that it has cost in all £33,697, an excess of £3000 above the estimate in 1885. The fittings and machinery have cost £1900 more than was estimated, and the foundations had to be made stronger at a cost of £450. The Financial Board state that they have every reason to believe that the University has full value for the outlay. The building and fittings are substantial and well adapted to their purpose. Prof. Liveing reports that the lecture-rooms are such that the audience can both see and hear, can sit comfortably and write with ease, and that the laboratories will bear comparison with the best of those to be found elsewhere.

£200 is asked for the purchase of additional apparatus for the Pathological Laboratory (the old Chemical Laboratory).

At Cavendish College eight scholarships of £30 per annum will be offered on July 23 next to students who will be under eighteen years old on October 1 next. One or more may be given for natural science (chemistry, physics, botany, geology, in all of which there will be a practical examination). Further particulars may be obtained from the Master of Cavendish College.

SCIENTIFIC SERIALS.

Bulletins de la Société d'Anthropologie de Paris, tome 11, fasc. 3, 1888.—Continuations of M. G. Hervé's observations on the cerebral convolution known as "Broca's." Great importance attaches to the discovery by the late eminent M. Broca of this anatomical characteristic in man, which he found to be absent in all animals below the Anthropomorpha, and while it appears in the latter only in a simple and rudimentary form, it is fully developed in the human brain. This fact in itself gives support to the hypothesis that intermediate types, now lost, must have been interposed between man and the still existing forms of the Anthropomorpha, and yet more important are the results yielded by recent physical researches, which clearly show that the normal human brain possesses a quadruple system of the frontal convolutions due to the doubling of the binary frontal lobes, while in Broca's convolution we must, moreover, recognize the origin and function of speech and memory. In the microcephali, in idiots, deaf-mutes, and in all persons of inferior intelligence, this convolution is more or less atrophied, especially within the insula or centre, where it unites with the other frontal convolutions near the extremity of the olfactory channel. —Close of the statistical inquiry regarding the colours of the eyes and hair in France, by M. Topinard. After having collected the results of 180,000 observations, M. Topinard announces that he is about to incorporate them in a chart for France. Three memoirs have already been published as parts of this inquiry, embracing Tunis, Denmark, and Pointe du Raz in France. Among various other interesting results the curious fact has been deduced that where the race is of a mixed blonde and brunette character the hereditary blonde colouring is especially manifested in the eyes, while the brunette element has a tendency to reappear in the hair.—On the origin and intellectual evolution of the pointer dog, by M. C. A. Piètrement. This is a *résumé* by the author of a special section of his great work regarding the legislative enactments in force under the Frank kings of the two earliest dynasties, concerning domestic animals. Beginning with a notice of the fourteen species of house and sporting dogs to be recognized on the monuments of Egypt, Assyria, and Nineveh, he goes on to the references in Greek and Roman writers to the dogs known in their time, in which he finds no indication that pointers and setters existed in their present stage of development as sporting dogs before our era; while, on the other hand, he proves by extracts from the lists of birds and other animals used in the chase, given in the capitularies of Dagobert, that falconry, whose introduction into Western Europe is usually ascribed to the Crusaders, was practised in Gaul as early as the seventh century. The article although long and verbose, contains much interesting information regarding sport among the Franks and Gauls since the time of the Romans.—On the long bones found at Spy, by M. Topinard. The sudden angular deviation of the tibial bones leads to the inference that the lower extremities of the men of Spy were half-flexed, as is generally the case in the arboreal Anthropomorpha.—Cut flints found at Pierrefitte, by M. Simoneau. These finds were taken from the lime-beds of Toucy, and were obtained through the agency of shepherd-boys, successfully enlisted in the work of collecting.—On the grouping of pyramidal cellules in the motor region of the limbs, by M. Mahoudeau. These researches prove the existence of microscopic functional centres in certain parts of the brain, which may be regarded as the true physiological elements of the cerebral organ.—Replies made by M. Bink, while stationed in New Guinea, to the Society's printed category of questions regarding sociology and ethnography.—Report of M. Nicolas on the graves found in the gravel beds of Gadagno (Vaucluse), which he assumed to be of the Stone Age, but which are now shown to have a Ligurian character.—On the dolmens of Kergo, Carnac, by M. Gaillard, who, in another communication, treats of a curious circumstance in regard to the system of arrangement followed in the lines of menhirs in Morbihan. Here he found that a single stone, having a rounded top, was interposed at irregular distances between the regular lines of menhirs, which it always exceeded in height. Continued observations showed that on different and special days of the year, the sun appeared, at its rising, to rest upon the summit of one or other of these isolated menhirs.—On graves containing cinerary vessels belonging to the Polished Stone Age, in the *commune* of Montigny-l'Engrain, by M. Vauvillé.—Observations on the restoration of the tumulus of Kerlescan, by M. Gaillard. The cromlech, which has here been readjusted, consists of twenty-nine of the ancient menhirs, which had escaped destruction.—On the form of the wrist in supination and pronation, and on the differences of outline exhibited by the metacarpal bones when observed on the skeleton, or when the cuticle has been removed, and the muscles have been laid bare, by M. Cuyer, who writes for the artist rather than the anatomist, and illustrates his remarks by various useful woodcuts.—On the relative length, among various peoples, ancient and modern, of the index and ring finger, by Colonel Duhousset.—On the relative length of the two first toes in the Mongolian races, by Dr. Maurel.—On the significance of the practice of measuring the throat of young women, common among the peasantry of Brittany, as well as various Kabyle tribes, by M. Letourneau. Among these remotely separated peoples, similar notions prevail as to the connection between the volume of the neck in women and the age of puberty. The practices that have arisen from a popular belief in regard to this relation are so nearly alike in both instances as to suggest some common origin.—The importance of studying the character of the masticatory process and apparatus, in judging of the nature and habits of mammals, when considered from an anthropological point of view, by Dr. Fauvelle.—On the survival of communal proprietorship in the Morbihan, by M. Letourneau. In this district, various ancient customs still prevail, and in the Islands of Hœdic and Houat, the *curé*, assisted by a council of notables, governs the islands after a patriarchial or fatherly fashion.—A communication, by M. Variot, concerning a new method of effacing the traces of tattooing.

Rivista Scientifico-Industriale, December 31, 1888.—The Chladni figures and Wheatstone's methods, by Prof. Lodovico Malavasi. Here the author proposes to apply Wheatstone's theory on the acoustic vibrations of square plates to the explanation of the figures observed by Chladni in rectangular plates.—The same number contains some remarks by G. Cariati on Mr. Edison's perfected phonograph; and on the solar photographs taken by Prof. Riccò at the Observatory of Palermo.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, February 7.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—The Rev. E. S. Marshall exhibited several interesting varieties of British plants collected by him in Scotland, and made remarks thereon.—Mr. E. M. Holmes exhibited a new British seaweed from Bognor, *Rhododermis elegans*, var. *polystromatica*, a variety new to science.—A paper was then read by Mr. A. D. Michael on three new species of parasitic *Acari* discovered by him in Derbyshire during the autumn of 1888. These were a *Myocoptes*, proposed to be called *M. tenax*, parasitic on the field vole, *Arvicola agrestis*; a *Symbiotes*, proposed to be called *S. tripilis*, parasitic upon the hedgehog; and *Goniomerus masculinus* (gen. et sp. nov.), a minute parasite found on the ear of the field vole. Specimens of all three were exhibited under the microscope, and a discussion followed, in which Profs. Mivart, Stewart, and Howes took part.—Prof. Martin Duncan then gave the substance of an important paper which he had prepared, entitled "A Revision of the Families and Genera of the *Echinoidea* Recent and Fossil." Reviewing the labours of his predecessors, Prof. Duncan traced the growth of the literature of his subject, and showed that, although many lists and papers had been published from time to time, no general review of the class *Echinoidea* had been attempted since 1846. Dealing with all the material at his command, he found it necessary to propose certain alterations in the classification, and to dispense with a good many genera and sub-genera which he considered had been needlessly founded. Above all, he had set himself the task of revising the descriptions of the genera, giving positive instead of comparative characters, a course which he believed would prove of great utility to students. The paper was criticized by Mr. Sladen, Prof. Stewart, and Mr. Breeze, all of whom testified to the necessity which had arisen for some authoritative revision of the subject such as had been undertaken by Prof. Duncan, whose researches would undoubtedly lighten very considerably the labours of future inquirers.

Physical Society, February 9.—Annual General Meeting.—Prof. Reinold, President, in the chair.—The Reports of the Council and Treasurer were read and adopted. From the former it appears that the number of members has only slightly increased during the year, due, it is supposed, to the advantages offered by the Society not being generally known, and a fly-leaf has been prepared, giving a short account of the Society's objects and procedure, copies of which may be obtained from the Secretaries. During the past year vol. i. Part 1, of "Physical Memoirs selected and translated from Foreign Sources," has been printed and issued to members; and the translations of important memoirs by Fourier, Hittorf, and Volta are well advanced, and will be published shortly. The Treasurer's Report showed the financial position of the Society to be very satisfactory. Owing to the lamented death of Prof. Clausius, a vacancy has occurred in the list of honorary members, to fill which Prof. R. W. Bunsen was nominated by the Council and duly elected. The following gentlemen were elected to form the new Council:—President: Prof. A. W. Reinold, F.R.S.; Vice-Presidents: Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, F.R.S., the Right Hon. Lord Rayleigh, Sec. R.S., ; Secretaries: Walter Baily, Prof. J. Perry, F.R.S.; Treasurer: Prof. A. W. Rücker, F.R.S.; Demonstrator: C. Vernon Boys, F.R.S.; other Members of Council: Hon. R. Abercromby, T. H. Blakesley, W. H. Coffin, Conrad W. Cooke, Prof. O. Lodge, F.R.S., Prof. W. Ramsay, F.R.S., W. N. Shaw, Prof. S. P. Thompson, H. Tomlinson, and Dr. G. M. Whipple. Cordial votes of thanks were passed (1) to the Lords of the Committee of Council on Education for the use of the rooms and apparatus of the Normal School of Science; (2) to the Council and Officers of the Society for their services during the past year; and (3) to the Auditors, Mr. Inwards and Prof. Minchin, for examining the accounts. In returning thanks for the Council and Officers, the President attributed the great success of their meetings to the indefatigable zeal displayed by the Hon. Secretaries.—The meeting was then resolved into an ordinary science meeting.—Prof. A. S. Herschel, F.R.S., read a paper on physico-geometrical models, and exhibited a collection of geometrical figure models illustrating elementary forms of crystallographical and chemical form constructions. The subject, he said, had suggested itself to him as an important one for study some five years ago, from the possibility which he then discovered of effecting a four-limbed mechanical cycle, similar to a thermodynamic cycle, with a conically revolving pendulum, the mathematical conditions of whose motion involved the logarithum of the circle radius of the knob's revolution, as a quantity equivalent to entropy in the thermal cycle. The mechanical cycle may be effected as follows. Suppose the pendulum knob to be revolving at velocity V_1, and radius r_1; imagine the controlling force to decrease so that the radius varies from r_1 to r_2, the velocity remaining constant at V_1; then increase the controlling force to its original value, and simultaneously impart velocity to the knob to keep the radius constant at r_2, the final velocity being V_2. Next, further increase the controlling force so as to cause the radius to decrease to r_1 at velocity V_2; and finally, decrease the controlling force to its initial value, simultaneously retarding the knob till the velocity is V_1 at radius r_1. The net energy concerned in the operations was given as $W = (V_1^2 - V_2^2)\phi$; where $\phi = \log \frac{r_1}{r_2}$, and the cycle affords an illustration of transformation of gyratory motion into energy of reverberatory push along the axis. The logarithm ϕ is also measured by the area of a hyperbolic sector, and is connected (as was shown) with a sector of the circle which a lamp's conical beam would inscribe upon a square glass screen or plate dividing a long room of square cross-section into two parts. The conical beam prolonged through the glass then traces, on the walls beyond, hyperbolas, whose sectors from their summits are related to the circle's corresponding sectors by a well-known hyperbolocyclic trigonometrical connection. From this mode of constructing the connection, and from a discordance which it shows at the asymptote extremities with Euclid's definition of parallel straight lines, the author concludes that cubic space cannot be continuous in its structure, but must be, in a physically constructive sense, like material particles indestructively atomic or molecular. The models showed modes of constructing cubic space in various ways, chiefly by means of tetrahedra, octahedra, and dodecahedra, the common element of form in these being also shown to be the right-angled tetrahedron or "biquoin" obtained by dividing a cube into six equal parts by three planes through its diagonal. A model of Sir W. Thomson's soap foam figure, and some wooden models representing Haüy's polyhedral atoms and their combinations, were exhibited to illustrate the structural view thus taken of geometry; and chemical-figure models of the ring of tetrahedral carbon molecules in benzene, and of the asymmetric groups of similar atoms in active and inactive tartaric acid, were shown.

Zoological Society, February 5.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of January 1889.—Mr. Sclater exhibited a living specimen of the Thick-billed Lark (*Rhamphocoris clotbeyi*) lately received by the Society from Southern Algeria, and called attention to its structural peculiarities.—Mr. G. A. Boulenger read a paper on the species of Batrachians of the genus *Rhacophorus*, hitherto confounded under the name of *R. maculatus*, and pointed out their distinctions.—Mr. Sclater pointed out the characters of some new species of birds of the family Dendrocolaptidæ, which were proposed to be called *Upucerthia bridgesi*, *Phacellodomus rufipennis*, *Thripophaga fusciceps*, *Philydor cervicalis*, and *Picolaptes parvirostris*.—A communication was read from the Rev. O. P. Cambridge on some new species and a new genus of Araneidea. Two of these species (*Pachylomenus natalensis* and *Stegodyphus gregarius*) were based on specimens living in the Insect-house in the Society's Gardens.—A communication was read from Prof. F. Jeffrey Bell, containing descriptions of new or rare Holothurians of the genera *Plexaura* and *Plexaurella*.—Dr. Günther, F.R.S., exhibited and made remarks on some fishes which had been dredged up by Mr. John Murray off the west coast of Scotland, and were not previously known to occur in British waters, viz. *Cottus lilljeborgii* (Collett), *Triglops murrayi*, sp. n., *Gadus esmarckii* (Nills.) *Onus reinhardti* (Collett), *Fierasfer acus* (Brünn.), *Scopelus scoticus*, sp. n., and *Stomias ferox* (Rnhrdt.).—Dr. Günther also exhibited and described a specimen of *Lichia vadigo* (Risso), a species of which only a few specimens were previously known from the Mediterranean and Madeira. This specimen was obtained by Captain MacDonald on September 17, 1888, off Waternish Point, Isle of Skye. He also exhibited a hybrid between the Roach (*Leuciscus rutilus*) and the Bleak (*Alburnus alburnus*), sent to him by Lord Lilford from the River Nun, Northamptonshire.—Mr. Beddard read a paper descriptive of the coloured epidermic cell of *Æolosoma tenebrarum*.—Mr. Boulenger exhibited and made marks on a series of living specimens of Tortoises of the genus *Homopus* from Cape Colony, lately received by the Society from the Rev. G. H. R. Fisk, C.M.Z.S.

Geological Society, February 6.—W. T. Blanford, F.R.S., President, in the chair.—The following communication was read:—On the occurrence of Palæolithic flint implements in the neighbourhood of Ightham, Kent, their distribution and probable age, by Joseph Prestwich, F.R.S. The author stated that Mr. Harrison, of Ightham, has discovered over 400 Palæolithic implements lying on the surface at various heights and over a wide area around Ightham. A description of the physiography of the district and of the distribution of the various gravels and drifts was given, and in the absence of fossils, attention was called to the different levels at which the deposits occurred, and to their physical features and characters. Besides the river-gravels, two groups of unclassed gravels were described, one occupying a low level, and the other levels higher than that to which the river-drifts reach; the latter is of varied composition. In the case of the Shode valley, only beds below the contour-level of 350 feet in its upper part, and of 300 feet or less in its lower part, can be referred to the former action of the Shode, and those above this belong to a high-level drift of uncertain age. The composition of the various gravels was described in detail. The implements are found on the surface of the land at all levels up to 600 feet, and Mr. Harrison has discovered them at forty localities in the hydrographical basins of the Shode, the Darent, the Leybourne stream, and in part of the Thames basin. Two groups of implements extend far beyond the limits assigned to the river-drifts formed since the present hydrographical basins were established, and must be accounted for by some other means than those in connection with the former *régime* of the existing streams. A description of the general characters and variations observable in the implements was given. It is evident from the condition of most of the implements, that they have been embedded in some matrix which has produced an external change of structure and colour. In the case of the river-gravel sites, the question presents no difficulty. Three cases of implements have been found: (i.) where the flint still shows some of its original colour; (ii.) those of which the surface has turned from black to white, has been altered in structure, and acquired a bright patina, and which show no trace of wear; (iii.) those of which the flint has also lost its original colour, but has been stained, and is with or without patina,—these are generally much rolled. The characters of the first call for no comment. Those of (ii.) and (iii.) are very marked, and there is no difficulty in referring each to a distinct matrix. The implements of class ii. have been embedded in a stiff brick-earth, generally of a reddish colour, and those of class iii. seem to have lain in ferruginous beds of sand or gravel. Reasons were given for supposing the surface to have been once covered with a deposit of clay or loess, since denuded except where preserved in pipes, and that a continuous plane descended from the high range of the Lower Greensand to the Thames Valley, which has since been lowered 300 feet or more. It was also shown that the high-level deposits were formed anteriorly to the post-glacial drifts of the Medway and Thames Valleys. It is probable that the loess is a deposit from flood-waters, and that some of it may be referred to the Medway flowing at a higher level; but the highest deposits cannot be so accounted for, and the author referred to the possibility of glacial action, without insisting on it. The deposit on the chalk-plateau is abruptly cut off by the river-valleys, and the rudest forms of implements, such as those of Ash and Bower Lane, occur on this plateau at from 500 to 550 feet, and the author thinks they may possibly be of pre-glacial age. The changes which have taken place in the physiography of the district, and the great height of the ol chalk-plateau, with its clay-with-flints and southern drifts, poin to long intervals of time, and to the great antiquity of the rude implements found in association with these drifts. That the removal of the material indicates the existence of agents of greater force than those operating under the present river *régime* closes up the time required for the completion of the great physical phenomena, though the author's inquiry tends to carry man further back geologically than is usually admitted. After the reading of the paper there was a discussion, in which Dr. Evans, Mr. Topley, and others took part.

Entomological Society, February 6.—The Right Hon. Lord Walsingham, F.R.S., President, in the chair.—The President announced that he had nominated Captain H. J. Elwes, Mr. F. Du Cane-Godman, F.R.S., and Dr. Sharp, Vice-Presidents for the session 1889-90.—Lord Walsingham exhibited a larva of *Lophostethus dumolini*, Guer., sent to him by Mr. Gilbert Carter, from Bathurst, West Coast of Africa.—Mr. G. T. Porritt exhibited several melanic specimens of *Boarmia repandata* from Huddersfield, and, for comparison, two specimens from the Hebrides. Mr. McLachlan, F.R.S., remarked that melanism appeared to be more prevalent in Yorkshire and the North Midlands than in the more northern latitudes of the United Kingdom.—Captain Elwes read a paper entitled "On the Genus *Erebia*, and its Geographical Distribution." The author, after referring to the number of species and named varieties, many of which appeared to be inconstant as local forms, made some remarks on the nomenclature of the genus, and suggested that a better system of classification might be arrived at by anatomical investigation. It was stated that little was known of the early stages and life-history of species of this genus, the geographical distribution of which was Alpine rather than Arctic. The author remarked that it was curious that there was no species peculiar to the Caucasus, and that no species occurred in the Himalayas, where the genus is replaced by *Callerebia*; that none were found in the Himalo-Chinese sub-region, and none in the Eastern United States of America. He also called attention to the similarity of the species in Colorado and North-West America to the European species. Lord Walsingham, Mr. Waterhouse, Mr. O. Janson, Mr. McLachlan, Dr. Sharp, and Mr. Jenner-Weir took part in the discussion which ensued.—Mr. W. Warren read a paper entitled "On the *Pyralidina* collected in 1874 and 1875 by Mr. J. W. H. Traill in the basin of the Amazons."—Mr. C. J. Gahan read a paper entitled "Descriptions of New or little-known Species of *Glenea* in the Collection of the British Museum."—Dr. J. S. Baly communicated a paper entitled "Notes on *Aulocophora* and Allied Genera."

PARIS.

Academy of Sciences, February 11.—M. Des Cloizeaux, President, in the chair.—On the loss of gaseous nitrogen during the decay of organic substances, by M. Th. Schlœsing. In continuation of his previous communication of February 4, he gives the results of some of the experiments already described.—Fresh researches showing that the toxic property of exhaled air does not depend on the carbonic acid, by MM. Brown-Séquard and d'Arsonval. In three previous communications (November 28, 1887, and January 9 and 16, 1888) the authors showed the nature of the relations existing between pulmonary tuberculosis and the air exhaled from the lungs of human beings and domestic animals, as well as the toxic property of one or more substances derived from the lungs. Fresh researches here described show that the poison or poisons escaping with the exhaled air may kill even in small doses, and even without being injected directly into the arterial or venous blood. Subcutaneous injection killed seventeen of eighteen rabbits operated on, generally within twelve to twenty-four hours. In a large number of cases they found that pure carbonic acid (not charged with the vapours of hydrochloric acid) may be inhaled in considerable quantity in the atmospheric air by human beings, dogs, rabbits, and other mammals. The authors themselves breathed for over one or two hours an atmosphere containing 20 per cent of CO_2 without any marked inconvenience, and especially without any lasting consequence. Other still more crucial experiments satisfied them that the fatal results are due, not to the carbonic acid, but to some other toxic substances exhaled by patients suffering from pulmonary affections.—On the invasions of locusts in Algeria, by M. J. Künckel d'Herculais. A careful study of the available documents has convinced the author that the most disastrous years (1845, 1866, 1874) are those that coincide with the simultaneous appearance of the indigenous species (*Stauronotus maroccanus*) and of the foreign variety (*Acridium peregrinum*) arriving from Central Africa.—Observations of the new planet discovered on February 8 at the Observatory of Nice, by M. Charlois. This planet, which is of 12·5 magnitude, is the second discovered by the young astronomer within a fortnight.—On the reductions of the problem of *n* bodies preserving certain mutual distances, by M. Andrade. It is here shown that the already communicated solution of this problem for a particular case is the most general possible.—On the phenomena of electrolysis, by MM. Violle and Chassagny. The decomposition of water by means of an energetic current is accompanied by luminous and calorific phenomena, which were described by Fizeau and Foucault over forty years ago, and afterwards studied by many physicists. By employing a Gramme machine of 40 amperes with an electromotor force of 110 volts, the authors have been enabled easily to produce these phenomena, to observe them under clearly defined conditions, and to record some hitherto unnoticed circumstances, which are here described.—On the actinometric observations made at Kief, by M. R. Savelief. These observations had special reference to the phenomenon of solar radiation during the year 1888, and to the determination of the solar constant at Kief. M. Savelief's paper was followed by some remarks by M. A. Crova, who directed attention to the great interest it presented, as showing that the law of the annual variations of solar radiation is practically the same at Kief as at Montpellier; that the calorific transparency is greater at the former than at the latter station, and that the solar constant determined on a clear winter's day in Russia may attain the value of 3 calories. This is higher than any recorded at Montpellier, and approached only by the records of an actinometer placed on the summit of Mount Ventoux, which are about the same as those obtained by Mr. Langley during his remarkable researches on the top of Pike's Peak, Colorado.—On some reactions of the chlorides of mercurammonium, by M. G. André. After concluding his researches relative to the decomposing action of water on the amidochloride (*Comptes rendus*, cviii. p. 233), M. André determines the conditions under which the chloride of dimercuriammonium is transformed to amidochloride at contact with sal-ammoniac.—On amorphous bismuth, by M. F. Hérard. The author has succeeded in obtaining this substance by applying to bismuth the same process that he had already employed to obtain amorphous antimony, as described in the *Comptes rendus* for August 13, 1888.—Syntheses effected by means of cyanosuccinic ether, by M. L. Barthe. In a previous note (*Comptes rendus*, cvi. p. 143), MM. Barthe and Haller described the preparation of cyanosuccinic ether, obtained by making monochloracetic ether react on sodium cyanacetic ether. By means of that ether they have now obtained the following syntheses: (1) methyl cyanosuccinic ether; (2) ethylcyanosuccinic ether; (3) ethylethenyltricarbonic ether; (4) propylcyanosuccinic ether, of which the respective formulas are given.—Discovery of a new Quaternary station in Dordogne, by M. Émile Rivière. This station, to which M. Rivière has given the name of Pageyral, in honour of M. Mercier-Pageyral, lies about 2 kilometres from the celebrated Cro-Magnon Cave on the left bank of the Vézère nearly opposite Laugerie, and facing the islet of Malaga. A first exploration has yielded the remains of the reindeer, *Cervus elaphus*, *Cervus capreolus*, *Sus scrofa*, *Canis aureus*, besides various objects of human workmanship characteristic of the Madeleine epoch, such as flint knives, scrapers, arrow-heads, cores, and numerous chippings.

BERLIN.

Physiological Society, January 18.—Prof. du Bois-Reymond, President, in the chair.—Dr. Baginski gave an account of his further researches on the Bacteria which occur in the fæces of children fed on milk. Of the two Bacteria which are thus found—namely, *Bacterium lactis* and *Bacterium coli*—he had previously experimented with the first, and proved that it does not induce a lactic acid, but an acetic acid fermentation of milk-sugar, and should hence more appropriately receive the name of *Bacterium aceti*. Recently he has investigated the *Bacterium coli*. Sown in a solution of milk-sugar it produces no change, but when some white of egg is mixed with it a fermentation is set up, not only when the access of air is permitted, but also when it is prevented. The products of this fermentation were proved to be, by an elaborate series of chemical investigations, lactic, acetic, and formic acids, the occurrence of the latter being proved by crystallographic measurements of its barium salts. Both the Bacteria exert an influence which is antagonistic to the development of any alkaline fermentations or decompositions.—Dr. A. König gave an account of his experiments on the action of santonate of soda on the perception of colours. As is well known, a distinction is drawn between congenital and acquired anomalies of the colour-sense (colour-blindness); of these the first only gives rise to colour-blindness to red or green, while colour-blindness to violet is never observed as a congenital defect. On the other hand, it was supposed that, in the anomalous perception of colour which results from the action of santonin or santonate of soda, we had to deal with a typical case of acquired colour-blindness to violet. The speaker had hence been led to make a number of experiments with santonate of soda on himself, and, apart from the fact that as soon as its action is manifest all objects appear of a yellow colour, had established the following phenomena. The spectrum ceases to be visible on the hinder side of the blue, and not a trace of violet is ever visible; the neutral point, as deduced from closely-agreeing measurements, is situated at wave-length 573—that is to say, exactly at that point which is complementary to the missing violet. The speaker based upon these observations the conclusion that the visual phenomena which are observed after the administration of santonin are not really of the nature of colour-blindness to violet, but can be completely explained by the assumption that the violet rays are absorbed by those media of the eye which have been affected by the drug. Prof. Preyer was unable to agree with the above conclusion, speaking with the experience of the experiments he had himself made with santonate of soda in 1868. The fact that after the administration of the drug the violet part of the spectrum can be seen when it is looked at not directly but indirectly, is opposed to Dr. König's views—that is to say, when its image is allowed to fall upon peripheral parts of the retina. Moreover, Prof. Preyer stated that he experienced a distinct sensation of violet when he had taken the drug while his eyes were closed, and then opened them after the action of the drug had become manifest. He believes that the visual phenomena which accompany the action of santonin can only be explained by assuming that it affects the central nervous system, and that this view is supported by the abnormal gustatory, olfactory, and auditory sensations which are simultaneously observed.—The President communicated some instances of the occurrence of real gustatory and olfactory dreams.

Physical Society, January 25.—Prof. von Helmholtz, President, in the chair.—Dr. A. König spoke on the dependence of visual acuteness upon the intensity of light when objects are illuminated by spectral colours, his remarks being based upon experiments made by Dr. Uhthoff. Earlier researches have shown that, for red, yellow, and green light, the visual acuteness increases at first very rapidly, then more slowly, and then finally shows scarcely any further change as the intensity of the illumination is increased; and that the curve of visual acuteness on the abscissæ which represent the varying intensity of illumination is a parabola, whereas with blue light the curve is a straight line. Dr. Uhthoff had repeated these experiments with spectral colours, taking care that the several lights used were in all cases of equal intensity, a result obtained by altering the width of the slit. The speaker described fully the apparatus he had used, and the series of preliminary experiments he had made, by which he had proved that the narrower the slit is in the screen upon which the spectrum falls, the greater is the acuteness of vision, and that the observations are more trustworthy when a dark mark on a light ground is used as the object whose brightness is to be determined than when a light mark on a dark ground is employed. As regards the apparatus it may be mentioned that the dispersion is produced by a fluid-prism 1 decimetre in diameter. The result of these experiments, as of former ones, was that the visual acuteness increases with the intensity of light in the blue part of the spectrum. When the visual acuteness is compared in the different spectral colours, the intensity of light being in all cases the same, a curve is obtained with a maximum lying near its centre. When the intensity of the light is less, the curve of acuteness on the abscissæ of the spectral colours becomes more pointed, and the maximum moves simultaneously towards the red end. When the intensity of light is the least possible, the maximum for the visual acuteness coincides with the point of greatest brightness in the spectrum. The above holds good not only for the normal trichromatic eye, but also for the dichromatic or red- and green-colour-blind eye.—Prof. Kundt exhibited a photograph of the spectrum of cyanogen extending from the line H up to about the line L, which had been sent to him by Prof. Keyser, of Hanover. For size, beauty, and clearness of the several groups of lines, this photograph is scarcely likely to find its equal.

Amsterdam.

Royal Academy of Sciences, January 26.—M. Buys Ballot communicated the results of his observations during the last forty years at the Meteorological Institute at Utrecht, and stated how much temperature, air-pressure, and rain deviated to the right or left from the mean values, and how long this occasionally continues on a stretch before compensation comes about.—M. Beyerinck spoke on a method of determining the action of different substances on the growth and on some other vital functions of micro-organisms, and illustrated his assertions by preparations. The method consists in applying small quantities of various substances on gelatine plates, either pure or prepared for the purpose, and infected with yeast or Bacteria of some kind or other, and then watching if the micro-organisms in the centres of diffusion of those substances—whether remaining pure or meeting each other on their way—multiply or not, or if they do so in a greater or less degree.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Electrical Trades Directory and Hand-book, 1889 (*Electrician* Office).—The Elementary Principles of Electric Lighting, 2nd edition: A. A. C. Swinton (Lockwood).—A Dictionary of Photography: E. J. Wall (Hazell).—A Manual of Cursive Shorthand: H. L. Callendar (Clay).—The Chemical Analysis of Iron: A. A. Blair (Whittaker).—Hourly Readings, 1886, Part 1, January to March (Eyre and Spottiswoode).—Greek Geometry from Thales to Euclid: G. J. Allman (Longmans).—*Challenger* Report, Zoology, vol. xxix. Text, 2 Parts (Eyre and Spottiswoode).—The First Ascent of the Kasaï: C. S. L. Bateman (Philip).—Therapeutics ought to become a Science: Dr. W. Sharp (Bell).—Therapeutics can become a Science: Dr. W. Sharp (Bell).—The Great Lake Basins of the St. Lawrence: A. T. Drummond.—La Pénétration de la Lumière dans les Lacs d'Eau Douce: Dr. Forel (Leipzig, Engelmann).—Die Zusammendrückbarkeit des Wasserstoffes: S. von Wroblewski (Wien, Tempsky).—Eskimo of Hudson's Strait: F. F. Payne (Toronto).—The Navajo Tanner: R. W. Shufeldt.—Journal of the Anthropological Institute, February (Trübner).—Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne, vol. x. Part 1 (Williams and Norgate).—Journal of the Royal Microscopical Society, December 1888 to February 1889 (Williams and Norgate).—Rendiconto dell' Accademia delle Scienze Fisiche e Mathematiche (Sezione della Società Reale di Napoli) Serie 2a, vol. ii. Fasc. 1° to 12° (Napoli).

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