THURSDAY, APRIL 29, 1897.

THE LIFE AND WORK OF CHARLES PRITCHARD.

Charles Pritchard, D.D., F.R.S., F.R.A.S., F.R.G.S., late Savilian Professor of Astronomy in the University of Oxford. Memoirs of his Life. Compiled by his daughter, Ada Pritchard. With an account of his theological work by the Right Rev. the Lord Bishop of Worcester; and of his astronomical work by his successor, Prof. H. H. Turner, F.R.A.S. Pp. viii + 322. (London: Seeley & Co., 1897.)

THE mere fact that the name of the late Prof. Pritchard is most widely known in connection with his astronomical researches, is in itself no uncertain sign of the energy and capacity of the man, for, as he himself stated, he did not really begin his astronomical work until he was seventy years of age. There are, however, other sides of his career for which he is little less worthy of grateful remembrance, exhibiting him, as they do, in the light of a pioneer in more than one important movement.

We therefore welcome the present volume, compiled by those who knew him best, giving a brief and interesting account of his life and work, which, it may be remarked, extended over nearly the whole of the century (1808–1893).

In a charming bit of autobiography, Prof. Pritchard tells the story of his schooldays, and of his struggles, ambition, and success as a schoolmaster. So far as one can judge, his early education was of the type then common, save for a short period during which he attended a private school kept by one John Stock, of Poplar, whose methods appear to have been far ahead of his time. The instruction of schoolboys in geometrical drawing, practical surveying, and the use of physical apparatus, was then (1822) no common undertaking, and this practical work seems to have influenced Pritchard very largely. It is at least certain that his mind was first seriously turned towards astronomy by a collection of Ferguson's models and astronomical instruments, which he had the privilege of studying at this "stirring school."

After a brilliant career at Cambridge, he entered a wider field as an educationist. Having been appointed to the mastership of the newly-founded Stockwell Proprietary Grammar School, he expounded his plans at the opening of the school, and only a few years ago he stated that "with the experience of half-a-century superadded, I can say with sincerity that had I now to form a scheme of education for a large school, it would be on the very same lines as those enunciated in my inaugural address." Suffice it to say that the main intention of his methods was the development of the *habit of thinking*, and as a step to its proper cultivation he proposed to introduce a well-furnished laboratory for the serious study of natural phenomena. He therefore claims to have been a successful pioneer in a most important branch of education. The sincerity of his convictions was afterwards proved when his energies were transferred to the Clapham Grammar School, which eventually passed entirely into his own management and proprietorship; not only did he actually establish the proposed laboratories, but he even went so far as to provide a swimming-bath and an observatory. While submitting to the system of examinations, Pritchard remained unconvinced of their utility, and he stated in 1886 that "the time will come when the competitives will be found to be intellectually and educationally suicidal."

Many of the pupils of the Clapham School have since become famous in various walks of life, and, among others, Dr. Bradley, the present Dean of Westminster, speaks of the great originality and success of the master's methods. Sir George Grove, another distinguished pupil, tells us in this volume how "geography became a reality," and the origin of the Palestine Exploration enterprise may be traced to the special attention given to that country at the Clapham School. One of the late Professor's favourite maxims, reiterated during his career as a schoolmaster, was "Whatever you do, do it as well as you can," and his whole life is a witness of his endeavour to act as he preached.

Pritchard's interest in astronomy took no practical turn until he had the means to add an observatory to his school, the most important part of the equipment being a fine transit instrument purchased at the close of the Exhibition of 1851. For private reasons the school was given up in 1862, and the observatory was removed to the new home at Freshwater, Isle of Wight. At this time Pritchard's repute as an amateur astronomer was so well established that he was elected Secretary to the Royal Astronomical Society, and within a few years he occupied the presidential chair. He took a very active part in the proceedings of the Society, and we have it on the authority of Prof. Turner, one of the present Secretaries, that his official connection with the Society has left lasting impressions on the conduct of its affairs.

The comparative retirement of the life at Freshwater ended in 1870, when Pritchard was appointed to the Savilian professorship. As Prof. Turner points out, he received this appointment rather on account of the man he was than for any conspicuous astronomical work which he had previously done, though, as subsequent events proved, he had only lacked the opportunity of doing justice to his observational ability. His association with the Astronomical Society here stood him in good stead, for he had given little evidence of his power except in ways of which the Society alone could take note, and his appointment was largely due to the representations of some of the more prominent Fellows.

The observatory, which was the scene of Pritchard's future triumphs, was at this time a very small one, but the authorities were soon persuaded to provide a 12-inch equatorial, and Dr. De la Rue's gift of his splendid instruments being made about the same time, an entirely new observatory was erected. The possibility thus opened for photographic work induced Pritchard to style the establishment "The New Savilian Observatory for Astronomical Physics at Oxford." As a matter of fact, however, the spectroscope has practically never been used in the observatory, so that in view of the meaning now attached to "astronomical physics," the observatory has lost the right to the name which Pritchard proudly gave it.

Practical instruction in astronomy was never greatly in demand at Oxford, hence nearly the whole strength of the small staff was available for research purposes, and especially in two directions, as all the world knows, success was complete. By the use of the wedge photometer, Pritchard raised stellar photometry to the dignity of an exact science, and by the employment of photographic methods he investigated the parallaxes of a large number of stars with results which are probably among the most trustworthy ever obtained in this branch of astronomy.

Another epoch in Pritchard's astronomical career commenced with his offer to take part in the work of the international photographic star chart. Such an undertaking, at his advanced age, was characteristic of him; and the fact that he successfully initiated the work, and left everything in order at the time of his death, illustrates the methodical way in which he set about it.

The successful issue of the various undertakings at Oxford was largely due, as Pritchard himself was always anxious should be known, to the zeal of his assistants, Messrs. Plummer and Jenkins, by whom most of the actual observations were made.

Prof. Turner has succeeded in weaving together an admirable account of Pritchard's astronomical work, but it may be remarked that all reference to his connection with the work of the Committee on Solar Physics has been omitted.

A hitherto unpublished account of Pritchard's observations of the total solar eclipse of 1860 is included in Prof. Turner's story, and though these were overshadowed by De la Rue's magnificent photographic results, it is evident that they were carried out with the forethought and skill which marked all his work.

The selection of correspondence between Pritchard and some of his great contemporaries has, on the whole, been judiciously made, and all concerned in the preparation of the memoirs are to be congratulated on the production of a volume which will be prized by all who knew Pritchard, and one which is at the same time of sufficient interest to command the attention of a much wider public.

WATER AND ITS PURIFICATION.

Water and its Purification. By Samuel Rideal, D.Sc. Pp. xii + 292. (London: Crosby Lockwood and Son, 1897.)

THE author of this work describes it on the title-page as "a handbook for the use of local authorities, sanitary officers, and others interested in water supply." It is thus admittedly a book which is designed more for the general reader than for the engineer, the chemist, or the bacteriologist. That this is so we have further evidence in the preface, where we read that—

"The closing of polluted wells, and decisions on new supplies, are now, however, in the hands of the general public, who, and their elected representatives, thus need to become acquainted with the results of the progress made during the last few years in bacteriology and knowledge of the causation of disease."

The book deals with the characters of different kinds of natural water, animal and vegetable impurities, the storage, filtration and distribution of water, the softening and purification of water, and lastly its analysis and the interpretation of results. On reading the book one finds that the author has not been able to refrain from including a large amount of technical detail, which is, however, treated too superficially to be useful to the serious student of the subject, and which must be of little or no use to the general reader. One cannot help wondering, for example, what sort of hazy notion the general reader will obtain from Figs. 61A-63, which show a colony of typhoid bacilli, and the typhoid bacilli themselves with and without flagella, the former called "spider" forms. The author is careful to inform the reader, on p. 266, that "the *size* of organisms is recorded in micro-millimetres = $\frac{1}{1000}$th of a millimetre commonly abbreviated μ'', but avoids recording either the size of organisms which are figured in the book, or the magnification to which they have been subjected, except in one case where the magnification happens to have been included in the descriptive letter-press copied with the figure from another book.

It is equally objectionable to place together in one plate, objects requiring differing degrees of magnification, as in Fig. 13, which exhibits in a single view a gigantic cyclops, spores of moulds, a zooglæa mass of bacteria, &c. Such figures may be well suited for advertisements of filters in order to show up the horrors of drinking water *au naturel*, but must prove somewhat misleading to the reader who obtains his first ideas of such objects from this book. On p. 256 the reader is informed that the flagella of bacteria "should be looked for by careful staining with iodine, fuchsine or other reagent." It would be advisable for any one who wishes to see these curious appendages of bacteria to select the "other reagent" referred to, for the employment of those named would be quite inadequate for his purpose. On p. 257 the author falls into the common error of supposing that aerobic organisms "are incapable of existing in absence of air"; as a matter of fact, when deprived of free oxygen they can lie dormant for very long periods of time, and wait for its advent as a signal for the renewal of their activity.

It is a little curious that an author who desires to inform his readers on such up-to-date topics as the staining of the flagella of bacteria, "spider-forms" of typhoid bacilli, and the latest methods of examining a sample of water for typhoid and cholera, should lay such stress on the history and properties of "the divining-rod." In the midst of a very useful *résumé* of facts bearing on the movements of water in various strata, on subsoil-water, line of saturation, "faults" and artesian wells, the author offers the following rather startling advice to the "local authorities and others" who may be in search of underground water. Instead of advising them to consult an engineer or geologist, as one would expect from the geological treatment of this part of his subject, we read on p. 77—

"It is worth while for any one who has occasion to seek for underground water, before going to the expense of boring, to employ *first* (the italics are the author's) a 'water-finder,' and at the same time to invite a scientific authority to test the process in detail without bias, as the practical success seems sufficient, if not to shadow a new law, like the discovery of the Röntgen rays, yet by explanation to put this peculiar power in a position where it could be more largely useful and less hesitatingly accepted."

From the account given of a certain experiment with the divining-rod, the unknown power seems to act even violently at times, for we read that "the tendency to twist itself on the twig's part was so great that on our holding firmly on to the ends it split and finally broke off."

We are even given the name and address of a "successful water-finder," "who states that he is only affected by running water and quite passive to stagnant." He says that "various kinds of wire or a watch-spring answer the same purpose as a twig or rod. A large number of people have the power to a certain extent." He adds, "I now use my hands alone, holding them out with palms towards the earth. I reckon the rod as an instrument only, and that the power itself is in the person."

On the same page, however, the last conclusion of the water-finder is contradicted by the experiences of a certain noble Lord with another "well-known 'dowser' or water-finder" (name and address given), for we read that "the effect produced on the twig emanated from a power outside himself." Moreover, the author states that "It" (the divining-rod) "is said to be still in vogue in Pennsylvania for petroleum, and in Cornwall for metallic lodes."

A very useful instrument apparently, and it seems a pity that its use is not better appreciated. The only form of "divining-rod" on which I should put the least trust, is one which may be seen nowadays carried about the streets of London by officials of the water companies, whose duty it is to detect "underground water" *running to waste*. Their instrument is certainly in the form of a rod, but it may be likened to a stethoscope, and its use depends upon its well-known acoustical properties rather than upon any mystic force still unclaimed by science.

The statements about the dissolved gases in water are exceedingly loose. On p. 251 we read that "a fully aerated water contains about 6 cc. of dissolved oxygen per litre." This is perfectly true for a temperature of 22° C., but for the cold water of winter 9 cc. is nearer the mark. A few words more would have explained the influence of temperature on the solubility of gases in water. On pp. 12-13, too, the following statement is misleading. "Water can dissolve at ordinary temperatures about its own volume of carbonic acid, 3 per cent. of oxygen and 1½ of nitrogen." Coming as it does after references to the fact that a fully aerated water contains, in the dissolved state, the natural constituents of the atmosphere, oxygen, nitrogen and carbonic acid, and that these gases are given off on boiling, one naturally concludes that these figures refer to the relative proportion of the three gases so dissolved from the atmosphere; but such is not the case, the figures refer to waters artificially saturated in the laboratory with the three gases in the pure state, and not mixed together as in atmospheric air, a fact which is not made clear. Naturally aerated, pure water contains, as a matter of fact, just about double as much nitrogen as oxygen. Again, on p. 191, the following inadequate statement is found: "Among the gases dissolved by water from the atmosphere, carbonic acid, being the most soluble, . . . occurs in the largest proportion." It is perfectly true that carbonic acid is the most soluble of the three gases of the atmosphere, but under the law of partial pressures, its greater solubility is more than counteracted by the small proportion of that gas present in the mixture, the result being that nitrogen (although having the lowest solubility of the three) occurs in the largest proportion, on account of its being present in the atmosphere in much greater proportion by volume than either oxygen or carbonic acid. Actual analyses of the gases given off on boiling in vacuo, from natural water having a surface freely exposed to air, often show less carbonic acid than nitrogen; but if the water has passed through strata containing carbonic acid, or is very impure, and bacteria are thriving in it and producing carbonic acid, this gas may exceed the nitrogen in volume; but in these cases the gas is not dissolved from the atmosphere, and in fact the excess diffuses into the atmosphere under conditions of perfect aeration.

Notwithstanding the defects which have been noted, the book is one which is well worth reading by "members of local authorities, sanitary officers, and others," for whom the book is avowedly written, who desire a general rather than a special knowledge of the present aspects of the subject, with all the recent advances which have been made in it. Nevertheless, as a little knowledge is a dangerous thing, local authorities will do well, when face to face with a water problem, to take the opinion of experts, and regard any knowledge gained by the perusal of this book as a negligible quantity where practical decisions have to be made regarding water supply or water purification.

For the serious student of the subject, who wishes actually to perform the chemical and bacteriological examination of water, or to make an independent interpretation of the results of analyses, the volume will be of little value. JOSEPH LUNT.

THE LAND OF THE LAMAS.

Mongolia and the Mongols. Results of a Journey made to Mongolia in the Years 1892-1893. By A. Pozdnéeff. Vol. i. Published by the Russian Geographical Society. 4to, pp. 696, with many photo-engravings. (Russian.) (St. Petersburg, 1896.)

THE author of this work is a well-known specialist in Mongolian and Manchurian dialects. He visited Mongolia, for the first time, in 1876, and brought home a remarkable collection of 972 volumes of both printed and MS. works on the history of Mongolia, which prove that our former conceptions of Mongolian historical literature, as being entirely permeated with an ultra-Buddhist spirit, were utterly incorrect. For the last fifteen years, M. Pozdnéeff was professor of Mongolian dialects and literature at the St. Petersburg University, and he has published a great number of smaller monographs on different subjects connected with Mongolian literature and administrative organisation, as well as a big work on Mongolian monasteries. His name is not unknown either in this country, as he edited for the Bible Society various publications in Mongolian, Kalmyk, and Manchurian.

The present volume contains the diary of his first year's journey, from Kiakhta to Urga, Ulyasutai, Khobdo, back to Urga, and thence to Kalgan, during which journey he visited several interesting monasteries on or near to his route, copying valuable inscriptions, minutely describing Buddhist, or rather Lamaite monasteries and temples, studying in the *yamuns* and in practice the administrative organisation of Mongolia under both the Chinese rule and the modifying influence of Mongolian common law, and paying attention at the same time to the interests of Russian trade in that immense territory, which begins to be dotted with Russian trade factories. In this work he was much helped by his wife, Mme. Olga Pozdnéeff, who travelled with him all the time, and by M. Fedoroff, who acted as a photographer of the expedition. Many of the photographs, chiefly of landscapes, ancient burial-places, old stone monuments, and monasteries, not to omit a portrait of the present grand-priest and "incarnation" of deity—the Urga *khutukhta*—are most interesting.

It is intended to publish the entire work in seven volumes, two of which will be given to the diaries of the expedition, one to the administrative organisation of the country, and one to Lamaism, which widely differs from the "Sakia-munism" that has lately been so much studied in Western Europe. The fifth volume will be devoted to various ethnographical materials, chiefly to folk-lore; the sixth, to trade; and the seventh, to a history of the prince families of Mongolia.

It would be utterly impossible to sum up in this place the volume which we now have before us. The routes followed by M. Pozdnéeff being well-known to geographers, only small additional geographical features could be gleaned here and there. On the contrary, the diary is full of small details about the features, the character, and the aspects of the towns of Urga, Ulyasutai, and Khobdo; the monasteries visited by the author; the organisation of the Chinese and Russian post in Mongolia; the relations between the local functionaries and the higher ones at Pekin, and so on. Some little scenes of the life of these functionaries, which are scattered through the diary, are worth pages of description, but they could hardly be mentioned without entering into many details. The same must be said of the monasteries, each of which has its own individual importance in the religious and political life of the country; Urga, for instance, which is the residence of the deity of Mongolia—the *khutukhta*—and the seat of a steadily increasing population of Lamas (they numbered 13,850 in 1889), is the political centre of the country—"its St. Petersburg," as the author says; while the monastery of Erdeñi-tsu is its "Moscow"—that is, the heart of the country, and a living witness of all the chief events of the history of Khalkha Mongolia, where every temple and chapel, and every one of the ninety-two towers of its outer wall has a significance for the inhabitants.

A special chapter, which has a real historical value, and gives a deep insight into the present conditions of Lamaite Buddhism under Chinese rule, is the chapter devoted to the "incarnations," past and present, of *bodisatva*, in the persons of the subsequent *khutukhtas*, or grand priests and deities of Urga. These "incarnations," as is known, take place in Tibet; that is, plainly speaking, a boy is selected for that purpose by the Tibet Lamas, and brought and enthroned with great pomp at Urga. The history of these "incarnations" for the last three hundred years is very edifying.

The second volume will contain the diary of the expedition during the year 1893. P. K.

OUR BOOK SHELF.

Rough Notes and Memoranda relating to the Natural History of the Bermudas. By the late J. L. Hurdis. Edited by his daughter, H. J. Hurdis. 8vo, pp. viii + 408. (London: R. H. Porter, 1897.)

That a group of islands where the list of resident native land birds comprises only seven species, in addition to which four maritime kinds frequent the coasts in summer, should be visited by no less than one hundred and twenty-eight other species, chiefly migrants, is a wonderful fact in natural history, and one worthy of the best attention of those interested in solving the problem of bird migration. To record the dates of the arrival and departure of these various migratory species, appears to have been the task set himself by the late Mr. Hurdis; and the present volume (portions of which have already appeared in another work issued as far back as 1859) is the result of his labours.

The work is in journal form, and is written somewhat after the style of White's "Selborne"; and if it lacks the charm of that classic, this can hardly be considered a fault on the part of its author. At the end of the notes on the Bermuda birds, a list of the migratory species is given. And here it is to be regretted that the dates of arrival and departure are omitted; while we look in vain for any theories of migration, or hints as to whence the wanderers came and to what lands they departed. But, in justice to the author, it must be remembered that the notes were written at a time when the importance of such observations was not ranked as high as it is at the present day.

It is not, however, by any means, to birds alone that the notes are restricted; and nearly a hundred pages are devoted to the other *feræ naturæ*, as well as to plants, climate and meteorology, geology, and the early settlement of the islands. The editor has, on the whole, discharged her share of the task well, although it would have been better had the repetitions of the names of the regiments to which the author's numerous fellow observers belonged been omitted. A few illustrations of birds and scenery would also have considerably lightened the perusal of a very readable book. R. L.

Das Wesen der Electricität und des Magnetismus auf Grund eines einheitlichen Substanzbegriffes. By J G. Vogt. Pp. 134. (Leipzig, 1897.)

In this pamphlet the author proposes a theory of electricity which is based on a new conception of the constitution of ether and matter. This conception of matter supposes that all bodies and the ether are to a certain extent continuous and made of the same material, there being in all cases an initial and final condition both of molecules and ether.

The reason for this new proposal seems to be more sentimental than substantial. The author does not consider that the modern molecule is an interesting body, as it has no object of its own in existence. The following sentences on page 7 of the introduction fairly represents the author's feeling on the subject:—"Es giebt nichts absurderes als der moderne kinetische Substanzbegriff nach welchem die Materie aus Atomen oder diskreten Massenteilchen besteht, die in der monotonsten Weise durch alle Ewigkeiten hin- und herschwingen. Etwas stupideres und sinloseres ist kaum denkbar, und nur trockene, vom bücherstaube der Jahrhunderte verschüttete Physiker konnten eine solche trostlose Idee aushechen."

The leading idea which the author introduces is that space is filled with continuous matter, and that there is distributed through it centres of condensation. Surrounding each of these centres is a quantity of matter, which forms a sphere. The material inside these spheres is always tending to become more condensed whether the sphere belongs to the ether or to an atom, which is merely a collection of these spheres in a very high state of condensation. To illustrate this tendency to condense, the author compares it with the tendency of the sun and stars to cool and contract, and eventually to form bodies like the moon. This theory of the constitution of matter, we are told, explains all the natural phenomena of light, heat, electricity and magnetism, without a single contradiction.

Having tried to upset the existing theories, and having told us that this new theory will explain practically everything, the author, to our surprise, fails completely to put forward convincing proofs in support of its application to electricity and magnetism. A good example of the class of explanation with which the pamphlet abounds is to be found on page 48, where the loss of electricity from conductors in damp weather is alluded to. A positively charged body is supposed to be surrounded by layers of negative ether spheres—that is, by spheres having a larger radius than the mean ether sphere. These negative ether spheres are in a high state of tension, and when a water molecule comes into the space which they occupy it relieves this tension, and so partly discharges the conductor. If we accept this explanation, there is absolutely nothing to prevent us supposing that small particles could discharge a conductor without touching it, or without being connected to it by any other material except the ether, as the author supposes that the layers of negative ether spheres, above alluded to, extend to finite distances from the conductor.

Experience, however, will not allow us to accept such an explanation at all, for it has been perfectly well established that the vapour rising from an electrified surface carries with it no charge. In connection with the magnetism of the earth we find, on page 90, an interesting piece of information. We are there told that it is only those heavenly bodies which rotate that have polarity, and that, *consequently, the moon is non-magnetic!*

It is consoling to learn that the author has suffered hitherto so much from hostile critics that he can no longer be stung by the suggestion that his philosophy is "blank Unsinn." J. S. T.

Farm and Garden Insects. By Prof. Wm. Somerville. Pp. viii + 127. (London: Macmillan and Co., Ltd., 1897.)

A USEFUL little *text-book* for beginners, and an excellent *reference book* for practical farmers. The three parts into which the book is divided are judiciously arranged. The first gives in a clear and distinct manner the rudiments of entomology, and forms, therefore, a useful introduction to the second part, which describes some of the most common insect pests whose ravages cause so much loss to the farmer and gardener. This loss may be very much modified if the simple precautions and remedies contained in the book are adopted. The appendix in a few pages gives most useful information about mites, ticks, &c.; not true insects certainly, but which, by attacking our domestic animals, and even man himself, cause an immense amount of irritation, inflammation, and consequent loss. Farmers, gardeners, and all interested in rural economy will do well to carefully study its pages.

Geology of North-east Durham. By D. Woolacott, B.Sc. Pp. vi + 84. (Sunderland: Hills and Co., 1897.)

THIS is an orderly account of the geological characteristics and history of North-east Durham. It is written in language easily understood by readers unacquainted with the elements of geological science, and will, therefore, interest a popular public as well as the student of British geology. The diagrams are very coarse; but this is doubtless due to the fact that they were prepared for publication in a weekly newspaper, in which the articles now reprinted originally appeared.

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.*]

Rate of Racial Change that accompanies Different Degrees of Severity in Selection.

IT is well known, in a general way, that better results are obtained by breeding from very select specimens than from the less select; but the statement deserves to be expressed with greater precision. I will do so here, on the lines laid down in "Natural Inheritance" (Macmillan, 1889), using the constants there determined for the stature of British men, including among them the coefficient by which female stature may be corrected to its equivalent male value, and thereby eliminating all trouble due to sexual differences.

On this basis, it will be shown, by way of illustrating a general problem, how much the stature of a breed of British men would be raised in each successive generation, under different specified degrees of severity in selection; also the utmost limits of stature to which they could be raised in the several cases, no change of type being supposed to occur in the interim.

Degrees of severity in selection admit of being defined by the method of *centiles* (or *percentiles*) fully described in the above book. No ambiguity need arise in interpreting such a statement, as that a man occupies the ninetieth centesimal grade in stature among a population whose mean stature is 68·5 inches, and whose individual statures are normally distributed about that mean with a quartile of 1·5 inches. Referring to Table 8 in the book, it is seen that the normal deviation at 90° in a series whose quartile is 1, is 1·90; therefore, in the above case, its value is 1·9 × 1·7 inches = 3·23 inches. The mean stature of the population is 68·50 inches, which has to be added to this, making a total of 71·73 inches. Consequently when it is said that those persons are selected for parents who occupy the grade of 90° in their respective series, the degree of severity in the selection has been strictly defined. Similarly in respect to any other grade, such as 80° or 70°. This method of defining severity of selection is applicable to every measurable character, and to every form of distribution, skew or other, revealed by observation.

The principle has been fully explained in the above book, by which successive generations of the same population are able to maintain the same statistical peculiarities notwithstanding the "scatter" of families. It was shown that the sons of parents of similar statures form a co-fraternity, whose mean is more mediocre than the parental statures. In other words, the mean of the co-fraternity *regresses* towards the mean of the race, the coefficient of regression in stature being 2/3. Thus the children of parents of grade 90° in stature, deviate on the average no more than 2/3 × 3·23 inches, or 2·15 inches, above the mean of the race. So much for the first generation of the selected parents.

In the second and subsequent generations, the "scatter" of the co-fraternities has to be considered. The quartile of every one of them was shown in the book to be 1·5 inches, consequently the individuals who occupy the grade 90° in a co-fraternity, are 1·5 × 1·90, or 2·85 inches taller than the mean of the co-fraternity, which itself is 2·15 inches above the mean of this race, making a total of 5·00 inches. The mean of their offspring, that is of the individuals forming the second generation of the selected series, is 2/3 of 5·00 inches, or 3·33 above the mean of the rest of the race.

These results are easily generalised and thrown into a formula, as follows: w = coefficient of regression; t = tabular deviation at the specified grade; q = quartile of race; q' = quartile of co-fraternity; $\alpha = tq$; $\beta = tq'$. Then the mean deviation of the pedigree stock from the mean of the race, in each successive generation, is:—

1st generation, $w\alpha$.
2nd ,, $w(w\alpha + \beta)$.
nth ,, $w^n\alpha + \frac{w - w^n}{1 - w}\beta$.

When n is large, w^n disappears and the limiting value becomes $\frac{w}{1 - w}\beta$. If $w = \frac{2}{3}$ as above, the limiting value is equal to 2β.

On these bases the following table is calculated :—

Excess of the mean stature of the pedigree breed in each successive generation, above that of the rest of the population, when both parents occupy the undermentioned grades in their own generation of the pedigree-breed.

Generation.	99°	95°	90°	80°	70°
	inches.	inches.	inches.	inches.	inches.
1	3·9	2·8	2·2	1·4	0·9
2	6·1	4·3	3·4	2·2	1·4
3	7·5	5·3	4·1	2·7	1·7
4	8·4	6·0	4·7	3·1	1·9
5	9·1	6·4	5·0	3·3	2·1
&c.	&c.	&c.	&c.	&c.	&c.
Limiting values ...	10·4	7·3	5·7	3·8	2·3

The importance to the breeder, of using highly selected parents, is *measured* by these tables, and shown to be very great. Thus one generation of the 99° selection is seen to be more effective than two generations of the 90° selection, and to have about equal effects with those of an 80° selection carried on to perpetuity. Two generations of the 99° selection are more effective than four of the 95°, and than a perpetuity of the 90°.

It must be borne in mind, that there is no stability in a breed improved under the supposed conditions ; but that, as soon as selection ceases it will regress to the level of the rest of the population through stages in which the deviation at starting, sinks successively to w, w^2 . . . w^n of its value. It may, however, happen that a stable form will arise during the process of high breeding, that shall afford a secondary focus of regression, and become the dominant one, if the ancestral qualities that interfere with it be eliminated by sustained isolation and selection. Then a new variety would, as I conceive, arise ; but into this disputable topic there is no need to enter now.

We can thus understand the facility with which races of butterflies acquire mimetic forms, the severity of selection in their case being very great, while one of their generations occupies only a year. FRANCIS GALTON.

The Effect of Röntgen Rays on Liquid and Solid Insulators.

OWING to my absence from Cambridge in the Easter vacation, I have not until to-day seen the paper by Lord Kelvin, Dr. Beattie and Dr. M. Smolan (NATURE, March 25), on the influence of Röntgen rays on electric conduction through air, paraffin, and glass, in which the authors state that they cannot detect any influence of Röntgen radiation on conduction through solids. I think that the difference between this result and the one obtained by Mr. McClelland and myself arises from the temporary character of the effect of the radiation on solids. The increase in the conductivity of solids is only appreciable for a short time after the application of the electric force (see NATURE, July 30, 1896, p. 306) ; under long-continued electromotive forces the conductivity seems unaffected by the rays. The effect might perhaps be more accurrately described as an increase in the electric absorption, rather than as an increase in conductivity. I have been for the past few months engaged in experiments on the effect of the rays on solids and liquids, particularly liquids ; and, though the experiments have been much interrupted by the pressure of other work, I hope soon to have them ready for publication. There is one experiment, however, which may be of interest. Of all the liquids tried, that sold as vaseline oil has proved the best insulator ; in its pure state it is very transparent to Röntgen rays, so to increase the absorption of these rays I stained the oil with iodine, when it became very opaque to them. The oil does not insulate so well after staining as it did before, but the effect of a slight amount of conductivity is not of importance when the following method is used. Three electrodes, A, B, C, are placed in a leaden vessel filled with the oil. B, which is between A and C, is connected to one pair of quadrants of an electrometer, A and C to the terminals of a battery of 1000 small storage cells. If there is any leakage the potential of B will, in general, not remain zero after the battery is put on, but it will do so if an earth connection is made at the proper place in the battery. The base of the vessel below B C was cut out, and an aluminium vessel inserted, so that the liquid between B and C could be exposed to the Röntgen rays. A balance was obtained with the rays off ; when the rays were turned on, the potential of B no longer remained zero, but changed in the way it would if the conductivity between B and C had increased. This effect was small but well marked, and seemed to last however long the electromotive force was kept on. J. J. THOMSON.

Cavendish Laboratory, April 24.

The Theory of Dissociation into Ions.

MR. SPENCER PICKERING has, in your number for January 7, brought forward certain difficulties which he says the advocates of the dissociation hypothesis have persistently ignored. I have been waiting in the hope that some one who supports the gaseous theory of solution as well as the theory of electrolytic dissociation would answer his letter. As no one has done so, I venture once more to trespass on your space.

First let me say that the experiment described by Mr. Pickering, in which water or propyl alcohol exudes through the walls of a semi-permeable vessel containing a mixture of these liquids, according as propyl alcohol or water is placed without, appears to me, as it does to him, to be very strong evidence that it is complex molecules of solution to which the walls are impervious. The experiment is one which certainly needs explanation at the hands of those who uphold the gaseous impact theory of osmotic pressure.

As I have already said, the idea that electrolytic conductivity depends on dissociation of the ions from each other, does *not* involve, as is so often assumed to be the case, the gaseous view of solution. The evidence for such dissociation appears to me to be exceedingly strong, as I will explain very briefly below, so that some explanation of the second experiment described by Mr. Pickering is necessary.

The experiment is this : The freezing point of a large quantity of acetic acid, to which is added a mixture of sulphuric acid and water in the proportions represented by $100H_2O + H_2SO_4$, shows that considerably less than 100 molecules have been dissolved. This result indicates that chemical union has occurred. Mr. Pickering says that, on the dissociation theory, the freezing point should be lowered by an amount corresponding to something between 101 and 103 molecules.

In such a case, however, we have conditions very different from those which hold when sulphuric acid is dissolved in water. In fact the liquid is in reality a mixed solution of water and sulphuric acid in acetic acid, or possibly, as Mr. Pickering suggests, of the hydrate of sulphuric acid in acetic acid. It does not at all follow that because sulphuric acid is dissociated in water, it is, therefore, dissociated in other solvents ; in fact, the freezing points of its solutions in acetic acid show that, on the contrary, aggregation has occurred. We should, therefore, expect that dissolving sulphuric acid in acetic acid would have little or no effect on the conductivity ; and this is also indicated by the low specific inductive capacity of acetic acid, which implies a low ionising power. There is no reason to suppose that the presence of a small quantity of water would modify the properties of the solvent enough to cause any appreciable change in the conditions.

But, even if these considerations were insufficient to explain the facts, the dissociation theory would not be discredited. As I pointed out in your issues of October 15 and December 17, 1896, dissociation of the ions from *each other* does not forbid the assumption that the ions are linked with one or more solvent molecules. Such a combination would explain Mr. Pickering's observation.

Mr. Pickering says that the dissociation theory depends solely on the numerical agreement obtained when properties of solutions are interpreted by its means. Although these numerical relations may have suggested the theory, they by no means furnish the only basis for it to rest upon. Other facts, to my mind, give much more conclusive evidence in its favour. As Mr. Pickering has challenged the supporters of the theory to explain his experiment, I may be allowed to ask the opponents of the theory to explain the following phenomena in any other way than by a dissociation of the ions from each other :—

(1) The velocity with which an ion travels through a dilute solution under an electric force is independent of the nature of the other ion present.

(2) The conductivity of a dilute solution is proportional to its concentration. The alternative to the idea of dissociation is to

imagine that the ions work their way through the solution by a continual series of interchanges between the parts of two solute molecules when in collision. The frequency of collision, and therefore the ionic velocity, would then vary as the square of the concentration, so that the conductivity would depend on the cube of the concentration.

(3) The potential difference at the contact of two solutions of different concentrations has the value calculated on the assumption that the ions migrate independently of each other, so that the faster-travelling ion enters the neighbouring solution first, and gives it a charge which continually increases till the electrostatic forces prevent further separation.

It is such phenomena as these, and not the numerical relations between conductivity and osmotic pressure effects, which seem to me to offer the most convincing evidence in favour of the dissociation theory. W. C. DAMPIER WHETHAM.

Trinity College, Cambridge, April 24.

Mosquito-Bites.

AN acquired immunity from the bites of mosquitoes and "domestic pests" is not uncommon in British India, and I have rejoiced in it myself, but should not trespass on you for space for details. I can give them to any of your correspondents who may care to ask me.

There is lying before me a queer old case of mosquito-bite reported by a good witness, Pedro Teixeira, who sailed from Malacca to Mexico in 1600 A.D., and crossed the latter from Acapulco to San Juan de Uluâ, on his way to Spain. Of this journey he says: "Almost all along this road is a plague of mosquitoes, so terrible and grievous that no defence avails against them, *and they stung my best slave to death*."

102 Cheyne Walk, Chelsea, April 9. W. F. SINCLAIR.

THE NATURAL HISTORY OF WORMS.[1]

THIS is the third volume that has been issued of "The Cambridge Natural History." The previous volumes are vol. iii., Molluscs and Brachiopods (reviewed in NATURE, lii. p. 149), and vol. v., Peripatus, Myriapods, and Insects (reviewed in NATURE, liii. p. 322). In the multitude of the divisions in the animal kingdom with which it deals, the present volume differs considerably from its predecessors. It is true that one may even nowadays find most, if not all, of the many forms of life here described included in one heterogeneous section entitled Vermes; but the editors of the present book fully recognise the great distinction that exists between such forms as the Platyhelminthes or flatworms, the Oligochæta or earth-worms, the Rotifera, and the Polyzoa, and they have very wisely distributed the various sections to authorities whom every one will recognise as among the most competent to deal with their respective subjects. Indeed it may be questioned whether the separation of the subjects has not been carried a little bit too far. It is true that pages ix. to xii. contain what purports to be the scheme of classification adopted in the volume, but this is little more than a table of contents, in which no attempt is made to show the relationships of the orders or families mentioned; and, apart from this, the only bond of union between the various sections appears to be the quotation, very happily adapted from André de Chénier, "Nous allons faire des vers ensemble." We should much like to have seen some attempt on the parts of the editors to present their readers, all of whom are not supposed to be familiar with the newest ideas of zoology, with a short introduction showing how and why it is that this "old group of Vermes" has gradually been dismembered, so that now we find not only such forms as the Platyhelminthes and the Polyzoa claiming to rank as independent phyla of the animal kingdom, but we also find, in the scheme of classification at all events, the genus *Phoronis*, the few forms composing the Dicyemidæ and Orthonectida, and the thirty or so genera of leeches placed on the same high level. When we are told, as

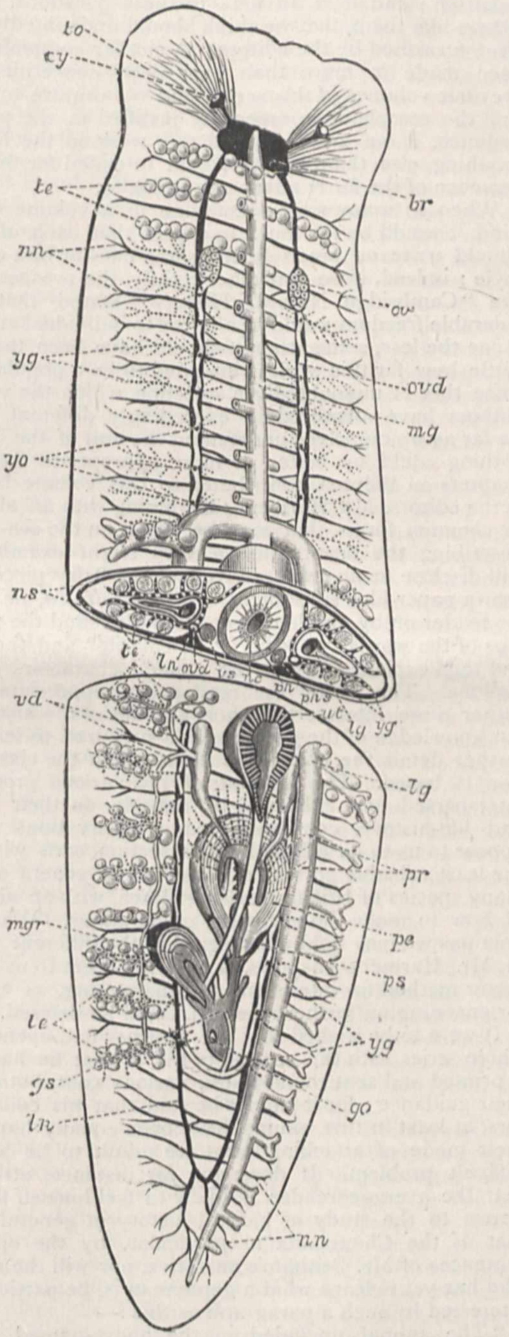


FIG. 1.—Diagrammatic view of the structure of *Planaria lactea*, a Turbellarian. × 7. The body has been cut across and a portion removed.

Mr. Gamble tells us, that the Turbellaria "occupy the lowest position in the whole group of worms," that they "are most closely allied to that great extinct group from which they, the Nemertinea, Rotifera, and even the Annelids, offer increasingly convincing evidence of having been derived," then we ask, What are we to

[1] "The Cambridge Natural History." Vol. II.: Flatworms and Mesozoa, by F. W. Gamble; Nemertines, by Miss L. Sheldon; Thread-worms and Sagitta, by A. E. Shipley; Rotifers, by Marcus Hartog; Polychaet Worms, by W. Blaxland Benham; Earthworms and Leeches, by F. E. Beddard; Gephyrea and Phoronis, by A. E. Shipley; Polyzoa, by S. F. Harmer. The whole edited by S. F. Harmer and A. E. Shipley. 8vo. Pp xii. + 560; with numerous illustrations in the text. (London: Macmillan and Co., Ltd., 1896.)

understand by "the group of worms"? What are the characters of "that great extinct group"? while there may even be many who will ask, What does Mr. Gamble mean by the Annelids? All these questions will be asked in vain, so far as the "Cambridge Natural History" is concerned, if we except one small allusion to the "old term Annelida," which occurs in Mr. Benham's contribution; and it is answers to these questions, and to others like them, that we think should undoubtedly have been furnished by the editors. A similar complaint has been made in more than one place concerning the previous volumes of this series, and we venture to think that the complaint is especially justified in the present instance, if we are to regard this work in the light of anything else than a cyclopædia intended for the convenience of the fairly advanced zoologist.

When so many writers combine in a volume of this kind, it would be too much to expect that each of them should write on precisely the same lines or in a similar style; indeed, if we remember rightly, the prospectus of the "Cambridge Natural History" stated that considerable freedom would be allowed to individual authors. None the less, some attempt should have been made to settle how far this work is intended to be a popular one, since this is undoubtedly a question which the various authors have answered in exceedingly different ways. So far as we ourselves understand the aim of the series, nothing could be better or more appropriate than the chapters on Polyzoa, contributed to this volume by one of the editors, Mr. Harmer. Beginning with an allusion to common forms that may be found on the sea-shore, describing the beauty that a very slight examination will disclose in an unattractive-looking "dry piece of a brown paper-like substance," *Flustra foliacea*, he leads his reader on by gentle degrees to understand the meanings of the words "zooecia," "avicularia," and the like, and then explains to him the general characters of the Polyzoa. This done, the reader can appreciate with rather more interest the short account of the history of our knowledge of the group, and is prepared to learn in further detail the characters upon which the classification is based. The account of the various groups is interspersed and enlivened by remarks on their habits and life-history, containing many observations which appear to us to be original. The section ends with not the least valuable portion, a guide to the genera and to many species of British marine Polyzoa, with an account of how to make the necessary preparations. Whatever opinions we may hold with regard to the different points in Mr. Harmer's chapters, it does not seem to us that a better method for interesting and instructing, as well as for encouraging further research, could be devised.

It were to be wished that Mr. Harmer had opened the whole series with this section of his, or that he had had it printed and sent round to the various contributors for their guidance; for it cannot be said that his collaborators, at least in this volume, have been equally happy in their mode of attacking what we admit to be a very difficult problem. It does not, for instance, strike us that the average reader is likely to feel himself further drawn to the study of natural history in general or to that of the Chætopoda in particular, by the opening sentences of Mr. Benham's narrative, nor will the reader who has yet to learn what a gephyrean is, be particularly interested by such a paragraph as this:—

"The animals included in the above-named group were formerly associated with the Echinodermata. Delle Chiaje states that Bohadsch of Prague in 1757 was the first to give an accurate description of *Sipunculus* under the name of *Syrinx*, but Linnæus, who noted that in captivity the animal always kept its anus directed upwards, re-named it *Sipunculus*. Lamarck placed the Gephyrea near the Holothurians; and Cuvier also assigned them a position amongst the Echinoderms. He mentions *Bonellia*, *Thalassema*, *Echiurus*, *Sternaspis*, and three species of *Sipunculus*, one of which, *S. edulis*, "sert de nourriture aux Chinois qui habitent Java, et qui vont la chercher dans la sable au moyen de petits bambous préparés"—a paragraph that forms Mr. Shipley's introduction to the group.

Adequately to discuss and to criticise these numerous contributions would lead us into details more fitted for a technical zoological journal; but there are one or two thoughts that have occurred to us in reading the book, and these may perhaps be mentioned.

Is it not rather misleading to retain a name of such definite meaning as the name Mesozoa for the strange animals that compose the families Dicyemidæ and Orthonectidæ, and moreover to print this name Mesozoa in the scheme of classification with similar type and in similar position to the names of the recognised phyla, when, as Mr. Gamble himself tells us, they "are most conveniently (and probably rightly) considered as an appendix to the Platyhelminthes"? If the name be kept at all, it should at least be explained to the inquiring mind what those features are which made Van Beneden, the discoverer of the group, consider these animals as intermediate between the Protozoa and the Metazoa.

A somewhat similar point is the hesitation as to the position of the Nemertines; they are treated in a separate section by a separate author, Miss L. Sheldon, and yet it is pretty clear that she inclines to the view that they should be placed among the Platyhelminthes—that is to say, if Bürger's recent discovery of flame-cells be not disproved We do not mean to say that we wish Mr. Gamble and Miss Sheldon to exercise anything but a scientific caution. Nevertheless, these are excellent instances of the questions that might so well have been discussed in a separate chapter by the editors.

There is naught of popular interest to be said about the Nemertines, so that Miss Sheldon's chapter, perhaps inevitably, reads much like an excerpt from the ordinary text-book of zoology. Mr. Gamble's lot is cast in happier places; he has to deal with the tape-worms, the liver-flukes, the formidable *Bilharzia*—the cause of hæmaturia, and other creatures of as much economic as zoological interest. With reference to the liver-fluke of the sheep, Mr. Gamble speaks as though its intermediate host were only the water-snail, *Limnæa truncatula*, or varieties of that species. The Rev. W. Fielder and others, however, in Victoria, have recently discovered large numbers of the peculiar stages known as *redia* and *cercaria* in species of other fresh-water molluscs belonging to the genera *Isidora*, *Segmentina*, and *Planorbis;* and since these larval stages are similar in form to those found in *Limnæa truncatula*, there is reason to suppose that we have to do with the ordinary sheep liver-fluke. In any case, a large number of intermediate hosts, not mentioned in Mr. Gamble's table on pp. 71 and 72, have been noticed by the energetic Victorian naturalists.

A similar addition might have been made on p. 143, where *Strongylus*, a genus of nematodes or thread-worms, is mentioned as being found in horses, cattle, and sheep, birds, and reptiles, but not as having been found in man. Looss not long ago described a species, *Strongylus subtilis*, found in the intestines of Egyptian fellaheen, while more lately still Prof. Ijima, of Tōkyō, has stated that a species, which appears to be the same, has long been known in Japan as a human endoparasite. A plague that in March 1889 spread among the inhabitants of the Miura peninsula appears to have been due to the growth of this species. Mr. Shipley mentions that no intermediate host has been satisfactorily demonstrated; it may, therefore, be of interest to mention that Dr. Ogata, who investigated the Miura plague, and first discovered the existence of *Strongylus* in the stomach of one of its victims, believed, after much investigation, that it had been brought about by the eating of certain oysters. The oyster has had so many attacks made on it of late, that it seems almost cruel to suggest that it might possibly serve as the host of this new endoparasite.

The next two writers present us in the course of their articles with a new classification apiece. Prof. Marcus Hartog deals with the Rotifers, animals which are known to all amateur microscopists in such beautiful and interesting forms as *Melicerta ringens*, with its little tube of pellets. It is, however, not only to the microscopist, but to the advanced morphologist, that the rotifers are, as Mr. Hartog says, "a subject of keen interest." The resemblance of some of them to the larval form known as a trochosphere caused Huxley, in 1851, to draw the conclusion "*that the Rotifera are the permanent forms of Echinoderm larvæ*, and hold the same relation to the Echinoderms that the Hydriform polypi hold to the Medusæ, or that *Appendicularia* holds to the Ascidians." The relation to the trochosphere has also been insisted on by no less writers than Lankester, Balfour, Hatschek, and Kleinenberg, while quite recently Haeckel has endeavoured to show that such a Rotifer as *Noteus quadricornis* presents a strong resemblance to what he, if not others, believes to have been the earliest type of Echinoderm. Mr. Hartog, however, has "been induced to take a view of the structure of Rotifers that brings it into close relationship with the lower Platyhelminthes, and with the more primitive larva of the Nemertines termed *Pilidium*."

"If we compare this organism with a Rotifer," he writes, "we find that the wreath corresponds in both, the funnel of the disc in such forms as Flosculariidæ and *Microcodon* leading to the mouth of *Pilidium*, while the gut is blind in Asplanchnidæ and in some of the highly developed Seisonidæ. The circular nerve-ring of *Pilidium* is in many Rotifers only represented by its anterior part, the brain, though in Bdelloids a sub-œsophageal ganglion completes the ring. This leaves a difficulty with regard to the apical sense organ; but it is easy to understand that an organ of sensation should become an organ of fixation. In this case the foot with its glands would correspond to the sense organ of the Trochophore larva; and it retains its primitive ciliated character in the larvæ and males of many Rotifera, and the adult female of *Pterodina* and *Callidina tetraodon*. Embryology tells us that the anus of Rotifers cannot be homologous with that of Annelids, &c., for it is formed outside the area of the blastopore: it is an independent formation, probably due to the coalescence of the originally blind intestine at its extremity with the earlier genito-urinary cloaca. On this view we must change the orientation of the Rotifer, and place it, like a Cuttlefish, mouth downwards: for 'anterior and posterior' we must substitute *oral* (or *basal*) and *apical*; for 'dorsal' and 'ventral' we must use *anterior* and *posterior*; while 'right' and 'left' are unchanged."

We do not altogether agree with Mr. Hartog's views regarding the apical sense-organ. Nevertheless, it does not necessarily constitute a serious difficulty, since it is well known that sense-organs can be developed afresh in almost any part of the body where they may be required. The whole suggestion, moreover, is extremely interesting, and so far as the needs of such a Natural History are concerned, we can have no quarrel with Mr. Hartog, seeing that, "as these views are now published for the first time," he has "thought it wiser to keep to the accepted relations in the general description, a course which has the advantage of avoiding difficulties in the study of the literature of the Class."

Mr. Benham, in dealing with the Polychæta, has not been so wise, for he adopts a classification that has previously been put forward, and that in a slightly different form, only at the meeting of the British Association in 1894, and has not yet met with any acceptance. This classification, however, he not only reintroduces, but permits to govern the whole arrangement of his section. Apart from our strong presentiment that few workers on the Polychæta will accept this classification without considerable question, we cannot think that it is altogether fair to the readers to introduce so great a novelty in what after all professes to be a popular work. Mr. Benham, however, as we have already hinted, can hardly claim to have made his contribution particularly popular, except, indeed, where he quotes, as we are glad to say he does pretty often, that fascinating and suggestive writer, Sir J. Dalyell. Passing to Mr. Benham's chapter xii., we find that it purports to contain a "description of British Genera and Species." It is true that a certain number of species found in the British area are described in more or less cursory fashion, but whereas some of the species so described are definitely stated to occur around our coasts, others are merely put down with such a locality as "Atlantic," and it is not always stated whether or no they can be regarded as British. In other respects, too, this heading is not quite accurate, for many of the species mentioned are not described, while others which do occur are not even mentioned. We may note in passing that the curious parasite of crinoids known as *Myzostoma*, recently found, by the way, to occur also in two genera of starfish, is regarded by Mr. Benham as a degenerate Chætopod.

The Oligochæta, which include the familiar earthworm, have been entrusted, most naturally, to Mr. F. E. Beddard. We notice that he includes in the group the little parasite of the crayfish, *Branchiobdella*, which, curiously, was omitted from his monograph. The family Discodrilidæ, in which it occurs, is placed among the Microdrili. Here also comes the family Phreoryctidæ, which Mr. Beddard considers to be low in the series, arguing from the generative organs of *P. smithii*. It should be noticed that Vejdovsky does not accept this position for the family, and would, in fact, refer this particular species to some other genus. In other respects, however, there can be little doubt that Mr. Beddard's account leaves small opportunities for criticism. There is just one small point in his account of the Hirudinea where, trying perhaps to be popular, he has fallen into a not uncommon error. "The former extensive use of the leech has led," he says, "to the transfer of its name to the doctor who employs it, the authors of the sixteenth century constantly terming a physician a leech." There seems little doubt but that it was the leech which derived its name from the physician. As Mr. Beddard's linguistic attainments might have shown him, the word *leech* is obviously derived from the Anglo-Saxon *læce*, a physician, a word which we still find in Scandinavian languages, as in the Danish *læge*. The use of *leech* as applied to *Hirudo medicinalis*, on the other hand, is strictly confined to the English language.

Following on the leeches comes Mr. Shipley with a remarkably up-to-date account of the Gephyrea, a group of some zoological importance as having so often and so long been placed with the Echinoderms, in consequence of their strong external resemblance to some Holothurians. Mr. Shipley, following most recent authorities, would derive them from the Chætopoda, their nearest ally in that group being *Sternaspis*, and would place the Echiuroidea nearest to that phylum, while the Sipunculoidea are regarded as allied to them, but as having departed further from the annelid stock.

It is perhaps a pity that the remarkable genus *Phoronis* should have been described in the present volume. It is true that earlier writers supposed it an off-shoot of the Gephyrea, and that Caldwell and Lankester have associated it with those animals along with the Brachiopoda and Polyzoa, more especially with the last. Mr. Shipley feels tempted to accept the recent researches of Masterman, which, if confirmed, must result in the placing of *Phoronis* among those peculiar allies of the early ancestors of the vertebrates known as Hemichordata. Perhaps it will be possible to introduce

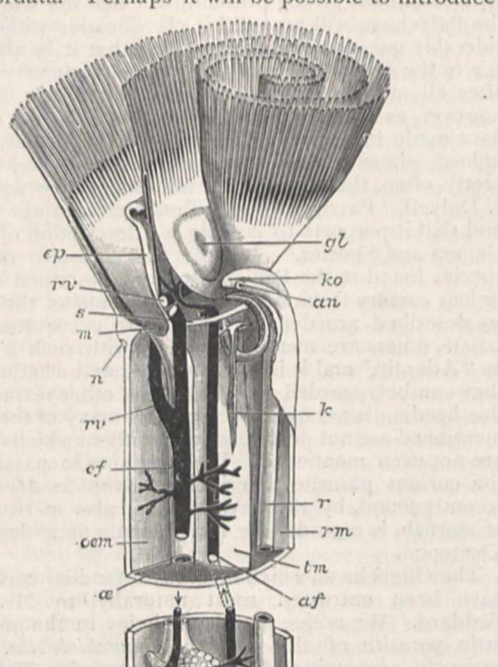


FIG. 2.—A schematic view of the interior of the body of *Phoronis*, with the middle ⅔ omitted. Magnification, which is great, is not stated.

it again in a subsequent volume for the convenience of comparative study. With regard to *Phoronis kowalevskii*, Mr. Shipley tells us that it is a name "given by

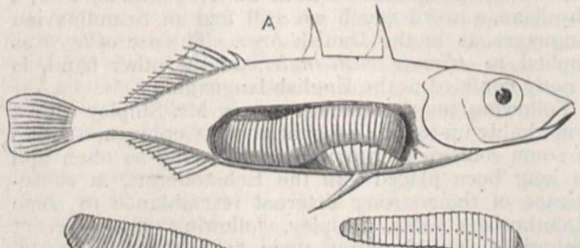


FIG. 3.—A. Stickleback (*Gasterosteus*) infested by an advanced larva of *Schistocephalus*. B. The larva. Both × 1½.

Benham to the species from Naples described by Caldwell, and replaces the name *Ph. cæspitosa*, which was given, but subsequently withdrawn, by Cori." This seems a roundabout way of stating that Cori s name was, as he has admitted, antedated by the name given by Benham. A name, once published, cannot be "withdrawn," even by its author

The volume concludes with an excellent index; but a review of any volume of the "Cambridge Natural History" that should conclude without an allusion to the admirable illustrations would indeed be incomplete. In this respect the present volume, though dealing with less picturesque animals, by no means falls short of its predecessors. As clear presentations of anatomical structure, we may draw attention to a diagram of *Planaria*[1] on p. 39, of *Leptoplana* on p. 14, of *Phoronis*[1] on p. 457, of *Alcyonidium* on p. 469, and many like them.

We may also notice the figures drawn from specimens in the Cambridge Museum, such as the stickleback[1] infested with a cestode larva, on p. 84, and many taken from the most modern writers, other than the authors, as Bürger, Haswell, Spencer, and others. Indeed, the only complaint we have to make with regard to the figures is that the name of the artist does not appear to be given in the volume.

Taken as a whole, the book is fully worthy of its place in this attractive series, and, even if the eye of a critical zoologist may detect a shortcoming here and there, his heart must be gladdened to see a general work published at last that treats these generally despised animals in a style to which their morphological importance entitles them.

INDIA-RUBBER AND GUTTA-PERCHA, AND THEIR SOURCES.

THE question of the supply of india-rubber to meet the present enormous demands caused by the progress of electrical science, and the rapid development of the application of the substance for cycle and carriage tyres, is one that has been much discussed of late, and continues to increase in interest. For some time past it has been well known that the trees which supply the best rubber known in commerce, namely, Para rubber, have been more and more difficult to get at, in consequence of the collectors having to proceed further into the forests in search of the trees (*Hevea brasiliensis*) which yield the valuable juice. But though greater distances have to be traversed in order to collect the rubber, there seems but little fear of the absolute failure of the rubber supply generally, or of this one particular kind. Though the quality of this rubber is of a very superior nature, we are fortunately not dependent alone upon it for the supplies of our markets, for from the East and West Coasts, as well as from Central Africa, and also from India and the Far East, we obtain very respectable quantities; indeed, the resources from tropical Africa in this respect have of late so much increased, that they promise to compensate for any loss of the American supplies, and the experiences of the past year or so, when a new source of rubber has been discovered at Lagos, is even more reassuring as to the future supplies, for other plants may yet be found capable of assisting in furnishing a substance that will probably, in the future, be in still greater demand than it is even now. So that it has become necessary for every one interested in this peculiar industry to take every precaution to prevent waste of material, both in the processes of collecting the milky juices and in the preservation of the plants yielding them.

It seems pretty certain that, whatever takes place in the discovery of new sources, the plants yielding these elastic juices must belong to one of three natural orders, for all the known plants furnishing rubber of commerce belong to the Euphorbiaceæ, the Urticaceæ,

[1] Reproduced here by permission of the publishers.

and the Apocynaceæ, as will be seen from the following summary.

EUPHORBIACEÆ (*Hevea brasiliensis*).—This is the source of the Para rubber already referred to, and the plant from which the earliest supplies of rubber were obtained when, in 1770, it first appeared in London as a new discovery for rubbing out pencil marks on paper, and realising about three shillings per cubic inch. At the beginning of the present century it began to be used in the treatment of woven fabrics, for air-tight and waterproof articles. So rapidly, indeed, did its use develop, that in the year of the Queen's accession Para rubber was imported into England to the amount of 141,735 pounds, and twenty years later it had increased to 3,477,445 pounds; while at the present time, when the trade returns are counted by hundredweights instead of pounds, the import accounts for 1896 showed the total of rubber from all sources to be 431,164 cwts., which were valued at 4,993,186*l*. The species of *Hevea* of which *H. brasiliensis* is the best known as a rubber producer are large trees, growing abundantly in the humid forests of tropical America, especially along the Amazon and its tributaries. As in most of the Euphorbiaceæ, the wood is soft and easily cut in the tapping process. The trees are locally known as Seringas. *H. brasiliensis* grows to a height of 60 feet, branching from the base. The collection of the milk commences about August, and is continued till the following January or February. In the wet season the milk is too watery to produce good caoutchouc. The trunk of the tree is wounded with a knife or a small axe-like instrument, a deep horizontal cut being first made a few inches from the base, and a vertical one from this, some distance up the trunk; oblique cuts are then made into this main channel, which conveys the milk into small clay vessels placed at the bottom to receive it. As these are filled they are emptied into a calabash or gourd, and when this is full it is carried to a more convenient place for coagulation; for this purpose, the contents of the calabash are emptied into a large earthenware basin. A kind of wooden paddle, with a widish blade and a long handle, is then dipped into the milk, and turned about over the smoke and heat of a fire made of the hard bony fruits of *Maximiliana regia*, or *Attalea excelsa*, which fire is enclosed with a thick earthenware covering, open at the top, like a small chimney, to allow the heat and smoke to escape. As the rubber coagulates upon the blade, in the form of a thin film, more milk is poured over it, and the same operation of holding it over the fire repeated. This goes on till a sufficient thickness of rubber is deposited, when it is cut through round the edge, and the paddle withdrawn. Various kinds of Para rubber are thus prepared, and are known in commerce under different names, according to the thickness of the deposit. The large round balls, generally known as "Negro-head," are made up of scraps of rubber tightly rolled together. This kind is often much adulterated, and one specimen in the Kew Museum contains in the centre, as shown when cutting the ball through, about one-third its weight of pieces of brickbat and cotton cloth.

Besides the process here described, some Para rubber is coagulated by the aid of alum, and by other means; but the quality of the rubber from this source is always good.

So far back as 1873, the necessity of securing supplies of rubber for future generations occupied the attention of the Kew authorities, and living plants of *Hevea brasiliensis* were sent to India, with the view of establishing the plant in that country. Smaller consignments were also made to the West Coast of Africa, Jamaica, Dominica, Trinidad, Queensland, Singapore and Java. The history of this important undertaking is fully recorded in the Reports of the Royal Gardens, Kew, for 1873, and subsequent years, where, indeed, will also be found recorded the various experiments made by Kew in the introduction of other rubber-yielding plants into countries that were thought suitable for their extension.

Another rubber-yielding plant of the Euphorbiaceæ is that which furnishes the kind known as Ceara Scrap, from the fact that this kind always appears in commerce in masses composed of agglomerated scraps. The plant is a native of Central America, and is known to botanists as *Manihot Glaziovii*. In 1876 a large quantity of seeds and plants of this species were collected in Central America, and brought to Kew; they were rapidly propagated, and plants were sent to Ceylon, Singapore, Calcutta, and other places, in most of which the plants grew rapidly and yielded rubber, thus proving their capability of establishing themselves in their new homes.

URTICACEÆ.—In this order we find also a Central American rubber plant in *Castilloa elastica*, which, with perhaps some allied species, furnishes the commercial kinds known as Guatemala, Mexico, and West India rubbers. *C. elastica* is one of the species that has received much attention at Kew, and in 1876 was widely distributed. The Indian source of rubber (*Ficus elastica*) also belongs to this group of plants. The plant is so well known as a parlour plant in this country, producing its fine glossy leaves under almost any conditions, that the fact is scarcely realised that in India and Ceylon it produces a veritable forest of trunks, and covers the ground with its long-stretching buttresses or roots, which run sometimes for distances of 30 or 40 feet. It is the source of Assam rubber, which is collected by wounding the stems and buttresses in all directions. The milk is collected either in holes made in the ground, or into leaves folded in the form of a vessel to receive it. On the upper parts of the stems, or on the branches, the juice is allowed to coagulate by exposure. The largest yield is obtained in August, when, on an average, a tree will give about 50 ozs. of milk, yielding about 15½ ozs. of pure rubber. To prepare it for market it is sometimes poured into boiling water, and stirred until it is sufficiently firm to be carried about without sticking together. It is shipped from Calcutta in baskets made of split rattan, and mostly covered with a gunny bag. When cut the rubber has a mottled appearance, and is composed of pieces varying from cream, or flesh colour, to a bright pink, or even red. It is either in the form of separate stringy-like balls, irregular blocks, or large masses.

Another species of *Ficus*, namely, *Ficus Vogelii*, furnishes one of the kinds known as Lagos rubber. The tree is known in West Africa as the "Abba," or "Abo," and is fully treated of in the *Kew Bulletin* for 1888, p. 253, and 1890, p. 89. The quality of this rubber was never considered very satisfactory, as it was more or less resinous, and was consequently used for mixing with other kinds rather than by itself. Another kind of Lagos rubber has, however, since been discovered, which has proved to be of superior quality, and is next described.

APOCYNACEÆ.—To this order belongs the several species of *Landolphia*, climbing, branching, shrubby plants, supporting themselves on the surrounding trees of the forest. The stems of these plants average from 4 to 6 inches in diameter, and the principal species, furnishing what is commercially known as African rubber, are *Landolphia owariensis*, *L. florida*, and *L. Kirkii*. The quality of these rubbers, though mostly good, is by no means equal to the Para kind, but the discovery of a new source of Lagos rubber, from a tree known to the natives as the "Ire" or "Ireh," has given a great impetus to the trade of the West Coast of Africa in a rubber of extremely good quality. The *Kicksia africana*, unlike the species of *Landolphia*, forms a tree 50 to 60 feet high, with a trunk averaging 12 to 14 inches in diameter. It is said to be one of the most beautiful trees of the forest, and is capable of producing in a good season as much as from 10 to 15 lbs. of rubber per tree. For the purpose of extracting the rubber, a deep vertical cut is made through the bark, and several oblique cuts on each side running into the main channel, at the base of which a vessel is placed to receive the exuding milk, which is coagulated by allowing a quantity to stand for some days in a cavity made in the trunk of a tree, so that the watery portion evaporates or soaks into the wood, leaving the solid portion behind, which is kneaded and pressed together into a solid mass, or the milk is placed in a vessel and boiled, the rubber beginning to coagulate almost immediately heat is applied. The whole history of this interesting discovery and development is given in the *Kew Bulletin* for 1895, p. 241, and 1896, p. 76, from which we learn that in January 1895, which practically marks the beginning of the industry, the exports were 21,131 lbs., valued at 1214*l.*, and at the end of December of the same year this had increased to such an extent as to show a total for the twelve months of 5,069,504 lbs., of the value of 269,892*l.* 13*s.* 10*d.*

As the *Bulletin* remarks, "The history of this new rubber industry in Lagos is full of interest, and illustrates the wonderfully rich resources of the vast forests of West Africa. It shows also very clearly how largely these resources can be developed by judicious and intelligent action on the part of the Government."

Besides the important sources of rubbers already mentioned, there are still others belonging to the same natural order Apocynaceæ, natives of the Far East, which may be briefly referred to species of *Willughbeia* and *Leuconotis*. *Alstonia plumosa* yields a rubber in Fiji, whilst *Forsteronia floribunda* and *F. gracilis* yield rubbers in small quantities in Jamaica and Demerara respectively, though not in sufficient quantities to be of any commercial importance.

From the foregoing list of plants, it will be seen how generally distributed the elastic juices are in Apocynaceous plants.

Space will scarcely allow us even to mention the allied substance gutta-percha, the history of the introduction, development, and threatened failure of supply of which is fraught with so much interest and warning: how that in 1842 the substance was first discovered in Singapore, and the trees cut down in such large numbers to supply the European demand, that in five years after only a few trees existed in Singapore, and a similar fate attending the trees which were afterwards found in Penang, are facts that are well known as applying to *Dichopsis gutta*, a sapotaceous tree, upon which the reputation of gutta-percha was at first founded, and from which the bulk of the commercial supplies have continued to be drawn, though it is more than probable that a similar substance is yielded in the East by allied trees, the botany of which, however, is but imperfectly known.

A substance very like gutta-percha is furnished by *Mimusops globosa*, a large forest tree, growing to a height of from 60 to 70 or even 100 feet, in Trinidad, Jamaica, Venezuela, and British Guiana. It belongs to the Sapotaceæ, and the solidified milk, or gutta, was first brought to this country in 1859. Its use with us has fluctuated very much, and it cannot be looked upon as a perfect substitute for true gutta-percha.

The interest at the present time is much greater towards the rubber supplies than those of gutta, and this is borne out by a few facts referring to the probable demand, in the very near future, that have appeared in a recent number of our contemporary, *Commerce*, among them being a statement that the estimated outturn of cycles in Great Britain and the United States during the present year will amount to 1,750,000; besides this, there is the probable development of motor carriages, and the extended application of rubber for the tyres of ordinary vehicles. So that there is every probability that the interest in rubber-yielding plants will go on increasing. JOHN R. JACKSON.

Museum, Royal Gardens, Kew.

THE RESOURCES AND THE NEEDS OF CAMBRIDGE UNIVERSITY.

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., Chancellor of the University of Cambridge, has requested us to give publicity to a statement as to its financial position and requirements, which has been drawn up for him by an influential Committee of residents, and whose authority he states to be unquestionable. Its purpose is to make known to the public the true state of the University's finances in relation to its increased duties, in the hope that means may be found for raising its endowments to the level of its present requirements.

The statement seeks to remove the impression that the University is a wealthy body. The fall in agricultural values has so seriously crippled it and its constituent Colleges, that this impression is no longer justified; and a point has been reached at which, without new endowments, complete efficiency and necessary expansion are gravely impeded. Benefactions for the establishment of special prizes and scholarships have not been wanting; but the flow of contributions for general academic purposes has for years practically ceased, though it is such gifts that are most needed, and at present most likely to be widely useful.

It appears that while the Colleges undertake much of the teaching for the degree examinations in mathematics and classics, all the higher branches, and the entire round of the natural and physical sciences, are provided for by the University, which maintains the library, the observatory, the botanic garden, eight museums, and eight laboratories. The University staff consists of about 120 professors, readers, and lecturers, whose stipends are paid partly by the common fund, partly by their emoluments as Fellows and Lecturers of Colleges. A Professor's stipend of 700*l.* or 800*l.* is diminished by 200*l.* if he holds a Fellowship; but in nearly all the Colleges the dividend is less than this sum, and the Professor, therefore, does not receive his full nominal stipend. By the statutes there should be twenty Readerships at 400*l.* each: the University has been able to establish six only, and these, in general, at stipends of about 100*l.* to 150*l.* The University Lecturers are usually selected from the College staffs, and receive, as a rule, stipends of 50*l.* a year.

In consequence of the conditions established in 1881, four-fifths of the Fellowships are now held by resident graduates. The maximum dividend is fixed at 250*l.*, but in fifteen out of seventeen Colleges this sum is not reached, and in some the dividend does not exceed one-third of the maximum.

The revenue for 1896 consisted of about 40,000*l.* derived from fees; about 16,500*l.* contributed by the Colleges as a tax on their revenues and tuition-fees; and about 6000*l.* obtained from the University endowments (tithes, rents, &c.). Of this sum, over 33,000*l.* was paid in stipends; over 22,000*l.* for the maintenance of libraries, museums, laboratories, &c.; some 2200*l.* in repayment of a loan for buildings; and 5000*l.* in part payment of necessary sites for new buildings adjoining the present museums.

From fees it is not easy to see how more can be derived without diminishing the number of students and graduates; the endowments are insignificant, and steadily decreasing in value; and the College contribution has already, in view of the financial difficulties of these corporations, been more than once reduced. When the tax reaches its maximum in 1902, the most it can yield, in addition to its present amount, is probably about 2000*l.*

On the other hand, greater expenditure is called for in various necessary directions. The museums and laboratories have been practically created within the present generation, but already many of them require considerable extension and better equipment. Important branches of study are rightly claiming recognition, but their demands cannot be met without heavy capital outlay. New sites have been secured, but the money to build on them is not forthcoming. The University library must be extended; the school of law is without a building; the lecture-rooms for the literary and philosophical subjects are wholly inadequate; there are neither central offices for University business, nor suitable rooms for University examinations; lastly, the laboratories for botany, zoology, and pathology must be rebuilt; the departments of physiology, physics, and engineering need speedy enlargement, and the school of medicine (including pharmacology) is practically beyond repair, and must be reconstructed on another site.

It is pointed out that while the total divisible income of the Colleges has fallen by 34 per cent. in the last fifteen years, the number of students has increased to 3000. Much personal devotion and sacrifice on the part of the teachers, much self-denial on the part of the Colleges which have not reduced their scholarships, and other encouragements for the poorer students, and much enthusiasm for the progress of science and learning on the part of all, must have gone to produce a result so creditable to the University. It appears to us that a fair case has been made out for its substantial re-endowment in respect of many of its departments; and, though no appeal for subscriptions is made, the facts related in the Chancellor's statement may well be pondered by those who are in a position to display a wise liberality in the cause of education, learning, and research.

NOTES

AT a meeting held on April 13, the Academy of Natural Sciences of Philadelphia conferred the Hayden Memorial Award for 1897, consisting of a bronze medal and the interest of the special endowment fund, on Prof. A. Karpinski, the Chief of the Geological Survey of Russia, in recognition of the value of his contributions to geological and palæontological science.

THE Budget Commission of the French Government has decided that the sum of four thousand pounds be voted for the Pasteur Institute at Rhia-Trang, to encourage Dr. Yersin's researches on the plague serum. The Chamber of Deputies is asked to adopt this decision.

THE *British Medical Journal* says there is a Bill before the New York State Legislature which provides for the establishment of a laboratory for the preparation of evidence for use in future trials for murder conducted by the State. In a recent case 1450*l*. was paid to medical witnesses for giving expert evidence. The object of the new Bill is to save this expense.

SIR EDWARD NEWTON, K.C.M.G., died at Lowestoft on April 25, in the sixty-fifth year of his age. The youngest son of the late Wm. Newton, of Elveden, in Suffolk, he proceeded to Magdalene College, Cambridge, where he took the usual degrees. Appointed, in 1859, Assistant Colonial Secretary of Mauritius, he successively became Auditor General and Colonial Secretary of that island, relinquishing the last post in 1877, on being appointed Colonial Secretary and Lieutenant Governor of Jamaica, whence he retired in 1883, through ill-health. He was a member of the mission sent by the Government of Mauritius to congratulate the late King of Madagascar on his accession to the throne; and, being an ardent ornithologist, availed himself of the occasion by materially increasing (as he did during a subsequent visit made with that express purpose) the knowledge of the very peculiar fauna of that country, which he was almost the first English naturalist to investigate on the spot. In like manner he largely increased our knowledge of the zoology of the Mascarene Islands generally, and it is mainly due to his exertions that nearly complete skeletons of the marvellous "Solitaire" of Rodriguez were recovered from the caves of that island, as described in the *Philosophical Transactions* of the Royal Society. Sir Edward was one of the founders of the British Ornithologists' Union, a Fellow of the Linnean Society, and a Corresponding Member of the Zoological Society of London.

WE regret to see the announcements of the death of Dr. E. S. Bastin, professor of botany and materia medica at the Philadelphia College of Pharmacy, and of Mr. Louis P. Casella, the well-known scientific instrument maker.

THE southern portion of Bronx Park, which the Commissioners of the Sinking Fund of the City of New York have just allotted for the use of the New York Zoological Society, embraces an area of about 260 acres. The city authorities will annually provide the funds for the maintenance and care of the buildings, animals and collections in the Zoological Garden which will be established in the Park; but the grant for the first year is not to exceed sixty thousand dollars. The erection and original equipment of the buildings, and the animals to stock them, have to be paid for by the Zoological Society, which has to raise one hundred thousand dollars by subscription before this time next year, and the further sum of one hundred and fifty thousand dollars within three years of the commencement of the work of converting Bronx Park into a Zoological Garden. Strong efforts are therefore being made to secure to the Society the sympathy and support of a large number of members. An attractive report on the plans and purposes of the Society has been printed and circulated, and in it Mr. William T. Hornaday, the Director of the proposed Garden, describes the zoological gardens of Europe, and dwells upon the advantages offered by Bronx Park. He holds that none of the Gardens he visited "occupies ground which can for one moment be compared, either in physical character or in extent, with the matchless site that has been chosen by this Society for the Zoological Park of America." One of the conditions of the grant of South Bronx Park to the Society is that the Zoological Garden and its collections shall be open free to the public for not less than seven hours a day, or at least five days a week.

THE Belgian Royal Academy announces prizes, mostly of the value of 600 francs, to be awarded in 1898 for essays on certain questions connected with the following subjects: In mathematical and physical science—on the critical phenomena, on theories of the constitution of solutions, on the correspondences (*Verwandtschaften*) between two spaces, and on the influence of the radical NO_2 in certain compounds. In biological science—on the macro- and micro-chemistry of digestion in carnivorous plants, on the physiology of some invertebrate animal, and on the organisation and development of the *Platoda*. A further prize of 1000 francs is offered, in memory of Jean-Servais Stas, for the best determination of the atomic weight of some element for which this constant is at present uncertain.

IN the last number of its *Proceedings*, the London Mathematical Society publishes the outlines of seven lectures on the Partitions of Numbers, which were delivered by the late Prof. Sylvester at King's College, London, during the year 1859. The outline of each lecture was printed shortly before it delivery, and copies handed to those in attendance. The Professor's attention was shortly afterwards diverted to another branch of mathematics, with the result that his researches on compound partitions have hitherto remained unpublished; but shortly before his death, Prof. Sylvester yielded to the suggestion of the Council of the London Mathematical Society, so far as to assent to the publication of these outlines with all their imperfections on their heads.

ONE of the most important problems now attracting the attention of seismologists is the choice of a system of stations in which to carry out the seismic survey of the world. In the plans so far proposed, advantage would, for obvious reasons, be taken of the existence of astronomical observatories, care being at the same time exercised to obtain a nearly uniform distribution of stations over the earth's surface. Prof. G. Grablovitz has recently, however, made the important suggestion that these stations should rather follow the distribution of volcanoes and the great lines of fracture of the globe. He points out that the majority of active volcanoes are situated close to three great circles, and he proposes that seismic stations should be founded near the six points of intersection of these circles, and near twelve other points symmetrically placed on the three circles. There are several obvious difficulties in the way of such an arrangement; but it is, nevertheless, one that deserves a very careful consideration.

IN the *Bulletin de l'Académie Royale de Belgique*, M. P. de Heen attacks the ordinary accepted theory of the critical point, according to which the horizontal portions of the isothermals of a substance gradually diminish to a vanishing point, and the extremities of these portions lie on a continuous curve whose tangent is horizontal at that point. M. de Heen maintains that the rectilinear portion of the isothermals does not vanish at the critical point, but that just after passing that point its direction gradually becomes inclined to the horizontal axis.

IN the *Monthly Weather Review* for January, of the U.S. Weather Bureau, Mr. A. L. Rotch gives an account of the cloud observations being made at the Blue Hill Observatory, Massachusetts, since May 1, 1896, in accordance with the request of the International Meteorological Committee. There are three theodolite stations in the same straight line, at which simultaneous observations of height and velocity are made twice daily, when conditions permit. Points on the clouds are selected by telephonic communication, and, when practicable, from three to five observations are taken on the same point, at intervals of a minute, and are reduced by simple trigonometrical formulæ. The theodolite measurements are supplemented by other methods, devised by Mr. Clayton, to determine the heights of the lower clouds, including the use of kites. It is found necessary to employ these additional methods, because the low clouds are so indefinite in form, or cover the sky with such a uniform veil, that it is impossible to measure them with theodolites or photogrammeters. We may confidently look for valuable results from these persistent and careful observations.

THE *Meteorologische Zeitschrift* for March contains an interesting communication on the oldest meteorographs, for which we are indebted to the indefatigable bibliographical researches of Dr. Hellmann. It was known from Birch's "History of the Royal Society," that Sir Christopher Wren had constructed a meteorograph about the year 1660; but a complete description of the apparatus was wanting, as only a portion of it was shown in the plate. But Dr. Hellmann has discovered both a description and a sketch of the instrument in the *Journal des voyages de M. de Monconys* (Lyon, 1665-1666). As this work is scarce, although a later edition of it is in the Library of the Royal Society (London), Dr. Hellmann quotes the passages referring to the meteorograph, and reproduces the sketch. The rain-gauge, forming part of the instrument, was the first of its kind. During a visit to London in 1663, Monconys obtained particulars from Wren of a hygrometer which he had also invented, and a description and sketch of this are given in the *Zeitschrift*. Wren, therefore, constructed the second condensation hygrometer; but this does not appear to be generally known, as no mention is made of it in Mr. Symons's "History of Hygrometers" (*Quart. Journ. Meteor. Soc.*, vol. vii.). The first condensation hygrometer was invented by Prince Ferdinand II. of Tuscany, about ten years earlier.

THE effect of hardness on the electrical and magnetic constants of steel, with particular reference to the tempering of the magnetic parts of instruments, is the subject of a short paper, by Dr. Carl Barus, in the March number of *Terrestrial Magnetism*. The following rules, given by Dr. Barus, for the practical treatment of magnets, where great secular permanence of magnetisation is the principal desideratum, should prove of great service in physical laboratories and to scientific instrument makers. (1) Rods tempered glass-hard are not to be used as essential parts of magnetic instruments. (2) Having tempered a given steel rod in such a way as insures uniformity of glass-hardness throughout its length, expose it for a long time (say 20-30 hours; in case of massive magnets even longer intervals of exposure are preferable) to the annealing effect of steam (100°). The operation may be interrupted as often as desirable. The magnet will then exhibit the maximum of permanent hardness for 100°. (3) Magnetise the rod—whether originally a magnet or not is quite immaterial—to saturation, and then expose it again for about five hours (in case of massive magnets even larger intervals of exposure are preferable) to the annealing effect of steam (100°). The operation may be interrupted as often as desirable. The magnet will then exhibit both the maximum of permanent magnetisation as well as the maximum of permanent hardness corresponding to 100°. Its degree of magnetic permanence against effects of temperature (less than 100°), time, and percussion is probably the highest conveniently attainable.

WORKING in the physical laboratory of the Massachusetts Institute of Technology, Mr. R. W. Wood has succeeded in producing diffraction phenomena with Röntgen rays. The source of the rays was an arc-like discharge between two very small beads of platinum in a high vacuum. The discharge bulb was only about an inch in diameter, while the radiation (which came from an area about the size of a pin-head) was strong enough to show the bones in the fore-arm. The "arc" appeared to be a new form of kathode discharge, and could only be produced under peculiar conditions. Mr. Wood used a tube with a platinum slit 0·1 mm. wide, mounted within the bulb at a distance of 2 mm. from the radiating bead. The second slit of variable width was placed at a distance of 10 cm. from the first, and the photographic plate at distances varying from 10 to 30 cm. from this. The images of the slit on the plate showed a distinct dark line on each edge, which could only be explained on the supposition that interference occurred. The plate was at too great a distance from the slit for such an effect to be produced by reflection of the rays from the edges. Images of fine wires showed similar phenomena.

THE study of the origin and significance of ornamental devices and patterns is engaging fresh workers. In a recent number of *Globus* (Band lxxi. p. 197), H. Strebel discusses certain ornamental motives of ancient Mexico. The series of designs with which he is here concerned are attributes of the Wind-god, Quetzalcoatl. The similarity of these devices from the Pueblo Indians, right down to Peru, indicate that there was an original community of culture.

THE directors of the Biltmore Herbarium have prepared a catalogue of the duplicate specimens in the collection, with the view of effecting exchanges. The list represents mainly plants indigenous to Western North Carolina, which have been carefully dried and, in many instances, specially prepared for distribution. The catalogue can be obtained from the curator, Mr. C. D. Beadle, Biltmore, North Carolina, U.S.A.

In June 1895, Messrs. P. A. Rydberg and C. L. Shear were commissioned by the Secretary of Agriculture of the United States to pay a three months' visit to certain points in the States of Nebraska, Idaho, Montana, Utah, and Colorado, for the purpose of collecting roots and seeds of grasses and other forage plants, and of obtaining information from farmers and others as to their economic value. The Report of this Commission forms *Bulletin* No. 5 of the U.S. Department of Agriculture, Division of Agrostology. A large number of grasses are described and figured, and notes are appended with regard to their value to agriculturists.

The St. Petersburg Society of Naturalists, section of Botany, proposes to issue a full herbarium of the flora of European Russia, similar to Fries's "Herbarium normale" and to Kerner's "Flora exsiccata Austro-hungarica." It will be issued in parts of fifty species each, under the editorship of S. I. Korzinski, and every person who will send to the editor (St. Petersburg University) two species, represented by fifty specimens each, will be entitled to receive one part of the herbarium. A preliminary communication with the editor would save the trouble of a double collection of the same species, in which case the person who has sent its plants first will have the priority. Each part will contain the species fastened to paper, or not if preferred, and each species will have a printed note giving the name of the plant, the spot wherefrom it comes, and various literary and critical observations. The copies which may remain over, after the contributors have been supplied with their parts, will be sold.

Delicate filaments of living matter flow out from the protoplasm of many one-celled animals, and exhibit remarkable movements. Similar thread-forming phenomena are said, by Gwendolen Foulke Andrews, to appear when the protoplasm of developing starfish and sea-urchin eggs are examined under very high powers; they are termed by the author the *spinning* activities of the living substance (*Journal of Morphology*, February 1897, vol. xii.). It is claimed that the filaments are projected from normal Echinoderm eggs; and that they are concerned in the formation of the egg membrane. The facts appear to point to a physiological drawing together of the cells by the filaments, rather than to any physical and chemical "cyto-tropismus." Also, a physiological, rather than a physical, reaction to mechanical stimulus of pressure or shaking is indicated; in fact, the cause of the spinning activities is held to be physiological rather than physico-chemical. For the living substance, cell-walls apparently do not a prison make, for we read: "Whatever may be the significance of the cell-wall in the development of these eggs, it surely cannot be thought a separator, in either a physical or physiological sense, of the cell contents from other portions of the common mass." Or, as put in other words, "the peripheral substance of eggs and cells is freely protoplastic, despite its appearance under less magnification of being a smooth and stable pellicle."

The following lectures will be given during May at the Royal Victoria Hall, at 8.30:—May 4, "Mountains of Skye," by Dr. T. K. Rose; May 11, "More about Röntgen and other Rays," by Prof. A. W. Porter; May 18, "Travel and Adventure in South Africa," by Mr. F. C. Selous; May 25, "Growth of the Colonies in the Queen's Reign," by Mr. O'Donnell.

We have received vol. xl. part v. and vol. xxx. part iv. of the Annals of the Astronomical Observatory of Harvard College. The first of these gives the observations made at the Blue Hill Meteorological Observatory under the direction of Mr. A. Lawrence Rotch, and contains an appendix, including summaries of observations for the lustrum and decade, a discussion of them, and a bibliography. The second of these volumes deals with a discussion of the cloud observations by Mr. H. Helm Clayton. This is described somewhat in detail, and several interesting plates showing, for instance, the average cloudiness during cyclones, anti-cyclones, their movements, and numerous annual and diurnal curves, illustrating average cloudiness at Blue Hill.

Four common species of the family Dermestidæ have become vegetarians; and their conversion forms the subject of a paper in *Bulletin* No. 8 (New Series), of the U.S. Department of Agriculture (Division of Entomology). Cyclopædias and text-books inform us that the members of this well-known family feed upon dried animal substances. The depredations of certain species on leather, hides, and dried meats; of others on carpets, furs, and woollen goods; and of still others on dried insects, and other "objects of natural history" are, unfortunately, too well known to require further comment. Within recent years, however, several household dermestids have been suspected of living in the larval condition upon vegetable substances, and the charge of having vegetarian proclivities has now been brought home to four species, viz. *Attagenus piceus*, or black carpet beetle; *Trogoderma tarsale*, a bad cabinet pest; *Trogoderma sternale*, and *Anthrenus verbasci*. The first-named is found guilty of feeding upon flour and meal; the second revels in fiery-red pepper; and the third species appears to be able to thrive on such laxative substances as castor-beans and flax-seed. The change from a natural animal-feeding habit to a vegetable one is attributed to altered environment.

We have just received the Report of the U.S. National Museum, under the direction of the Smithsonian Institution, for the year 1894. About two hundred pages of this report are devoted to reviewing the work accomplished in the various scientific departments of the Museum, and general administrative matters; the remaining five hundred pages are taken up with most valuable papers describing and illustrating collections in the Museum. These papers have already been referred to (p. 469), and we need only now give expression to the gratitude which all men of science feel towards the Smithsonian Institution for the many ways in which it extends knowledge among men.—Another recent publication by the Smithsonian Institution is "A Recalculation of Atomic Weights," by Prof. Frank W. Clark. This fifth publication in a series on "The Constants of Nature" comprises a full discussion and recalculation of atomic weights from all the existing data, and the assignment of the most probable value to each of the elements. The first edition was published in 1882. The enormous mass of new material which has since become available has been assimilated and combined by Prof. Clark with the old data in the present edition of his most handy work.

Dr. S. Schönland's report on the Albany Museum, Grahamstown, during the year 1896, shows satisfactory progress. Large additions have been made to the publicly exhibited collections, and the collections formed for purely scientific purposes have grown even more rapidly. A sum of three thousand pounds was voted by the Cape Parliament last year towards the cost of a new building to accommodate the increasing number of specimens. Plans have been prepared for the new museum, and it is hoped that Parliament will make a further grant to enable them to be carried out. The alarming spread of insect pests in the Eastern Province occupied the attention of the Committee of the museum for some time, and the conclusion was arrived at that it was largely due to the wholesale destruction of insectivorous birds. Steps have therefore been taken to protect useful birds and their eggs. Dr. Schönland has established a small private botanic garden for South African plants. He remarks that he was driven to this step, because there is, unfortunately, no public garden in Cape Colony for the study of the South African flora. The relics of pre-historic South African races were also studied during the year, some interesting finds being obtained from three caves at King's Quarry, Grahamstown. A number of peculiar drawings on rocks in Bechuanaland were examined by Dr. Schönland. Although there was no decisive evidence to show that they were the work of Bushmen, the facts obtained certainly point to that conclusion.

Among noteworthy articles and publications which have come under our notice during the past few days are the following:—"Storms and Weather Forecasts," by Prof. Willis L. Moore, in the *National Geographic Magazine* (March). Twenty-six full-page plates, illustrating the weather characteristics of the United States, accompany this article.—"Neural Terms, International and National," by Prof. Burt G. Wilder, reprinted from the *Journal of Comparative Neurology*, vi. (December 1896). A critical treatise on the principles and practice of anatomical nomenclature, with special reference to the brain.—"Zusammenstellung der Ergebnisse neuerer Arbeiten über atmosphärische Electricität," by Profs. J. Elster and H. Geitel (Jahresbericht des Herzogl. Gymnasiums zu Wolfenbüttel, 1897). Some years ago (1891), Profs. Elster and Geitel brought together, in the yearly report of the Wolfenbüttel Gymnasium, the investigations which had been made on atmospheric electricity. They have now collated the large amount of work done by others and themselves during the past six years. Their review is thus a valuable summary of the progress made in an important branch of scientific inquiry.—The *Procès-verbaux* of the International Committee on Weights and Measures, for the year 1895, and the *Comptes rendus* of the meetings of the second conference on weights and measures, held in Paris in 1895.—On the Artificial Production of certain Organic Forms, and the Manner in which they are Produced," by the late Mr. George Rainey (St. Thomas's Hospital Reports, vol. xxiv.). This paper is reprinted from the *Medical Times and Gazette* of 1868, and all practical workers in experimental physiology will be glad to have their attention drawn to it. Mr. W. W. Wagstaffe contributes a brief introduction to the reprint.—"A Summer Voyage to the Arctic," by G. R. Putnam (*National Geographic Magazine*, April). An account is given of a voyage to Umanak fiord, in the northern part of Danish Greenland, and several hundred miles within the Arctic circle. The magnetic observations made during this expedition are described by Prof. G. R. Putnam in the March number of *Terrestrial Magnetism*.—"Contributions towards the Bibliography of Photography in Colours," by Thomas Bolas (*Journal* of the Society of Arts, April 23). A valuable descriptive list of what has been published on colour photography since 1810.—A full and very appreciative obituary notice of the late Prof. Sylvester is contributed to *Science* of April 16, by Prof. G. B. Halsted, who was his first pupil in the Johns Hopkins University.—In a Catalogue of Mathematical Works offered for sale by Messrs. Dulau and Co., mathematicians will find many rare and valuable papers. The catalogue runs into 178 pages, and the names of authors are arranged in alphabetical order.

It is well known that when carbon is used as anode in the electrolysis of electrolytes from which oxygen is evolved among the products of decomposition, the carbon is attacked more or less rapidly. This is due partly to chemical action, partly to mechanical disaggregation. Mr. Alfred Coehn contributes an interesting note on this important subject to the *Zeitschrift für Elektrochemie* for April 5. The phenomena observed when dilute sulphuric acid is electrolysed with platinum kathodes, and carefully purified arc-lamp carbons as anodes, depend on the concentration of the acid. When an acid containing 500 volumes of water to one volume of concentrated sulphuric acid is used, the liquid gradually becomes dark brown; with equal volumes of acid and water, it remains colourless; with intermediate concentrations the depth of colour is intermediate. At higher temperatures the mechanical destruction of the carbon diminishes, and even the stronger acids become brown. The author has attempted to determine the electro-chemical equivalent of carbon, employing acid containing equal volumes of strong sulphuric acid and water, at a temperature of 100° C. Under these circumstances the mechanical destruction of the carbon appears to be small compared with the chemical attack. While 4·0085 grams of copper were deposited in a copper voltameter, the carbon anodes lost 0·4476 and 0·4537 grams respectively, from which the value of the equivalent is 3·5. In a second series of experiments, in which the concentration of the acid was varied considerably, and the fragments of carbon mechanically lost were collected, weighed, and deducted from the total loss of weight of the anodes, values were observed varying from 2·7 to 3. The author promises further details of the experiments in a future communicaton.

The additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin (*Cebus albifrons*) from Venezuela, presented by Sir William Hoste, Bart.; two Pin-tailed Sand Grouse (*Pterocles alchata*) from India, presented by Mr. W. H. St. Quintin; a Black-headed Gull (*Larus ridibundus*), British; two Rufous-necked Weaver Birds (*Hyphantornis textor*) from South Africa, presented by Mr. W. H. Dobie; a Cactus Conure (*Conurus cactorum*) from Brazil, presented by Mrs. A. G. Scorer; a White-crested Touracou (*Turacus corythaix*) from South Africa, deposited; a Crowned Lemur (*Lemur coronatus*) from Madagascar, a —— Spider Monkey (*Ateles variegatus?*) from South America, three Double-banded Sand Grouse (*Pterocles bicinctus*) from Senegal, purchased.

OUR ASTRONOMICAL COLUMN.

Peculiar Stellar Spectra.—Harvard College Circular (No. 17) continues the list of stars the spectra of which have been designated as "peculiar."

The table contains no less than nineteen stars, but we will confine ourselves in the summary to those of smaller southern declinations.

Designation.	Approx. R A. 1900.	Approx. Decl. 1900.	Mag.	Description.
	h. m.	° ′		
A.G.C. 9313	7 14·5	−24 47	4·6	Peculiar. 30 Can. Maj. Resembles ζ Puppis.
A.G.C. 10182	7 43·9	−25 42	5·3	Hβ bright. o Puppis.
	13 31·1	−55 58		Peculiar. Variable.
A.G.C. 22640	16 39·2	−46 54	7·4	Bright band, wave-length about 4700.
	20 8·5	−44 43		Peculiar. Variable.
A.G.C. 29191	21 11·5	−39 15	7·3	Peculiar.
A.G.C. 31272	22 55·0	−23 4	8	Peculiar.

In the notes it is mentioned that the third star in the above list "may resemble" that of ζ Puppis, since it contains two bright lines which may coincide with the lines having wave-lengths 4633 and 4688. ζ Puppis, 29 Canis Majoris, 30 Canis Majoris, and this star may form a subdivision of Type V. All these stars are near the central line of the Milky Way.

The fifth star was noted by Dr. Stewart as "bright-line star (faint)" on a Bruce photograph. An examination by Mrs. Fleming has indicated that the star is variable and the spectrum peculiar.

The Planet Mercury.—The length of the period of rotation and the physical features of the inferior planet Mercury have formed the subject of a recent investigation by Mr. Percival Lowell, the results of which are contributed to the *Astr. Nach.* (No. 3417). The conclusion he has arrived at, from a considerable amount of research, is that this planet rotates once on his axis in the course of its circuit round the sun. As regards the markings on the planet's disc, he describes them as being perfectly distinct, absolutely defined, and always visible. They are narrow dark lines, but not so fine as they appear to be. Their relative positions are permanent. Their positions from hour to hour do not change, thus eliminating any question of a short period of rotation. The permanency of the markings indicates the absence of clouds and other obscurations over the surface of the planet. With regard to an atmosphere, we are informed that there are no positive signs, either direct or indirect. There is, however, negative evidence against the presence of any perceptible atmosphere—namely, the low albedo of the planet, and the great contrast of the surface markings. Unlike Mars, the planet's surface is colourless, and there seems, further, to be no change in the markings, which might indicate presence of seasonal effects. The observations made at the Lowell Observatory are thus in accord with what would be expected, considering the isochronism of the orbital and axial rotations, and the small inclination of the axis to the plane of the orbit. Without an atmosphere, and therefore waterless, the visible surface of the planet may be looked upon, as Mr. Lowell remarks, as "one vast desert."

It may be remarked that M. Leo Brenner, who has also made some recent observations of this planet's surface markings, has, in a recent number of the *Astr. Nach.*, come to a somewhat different conclusion. The spots, he says, are remarkably clear, and a comparison of drawings has indicated that the period of rotation of the planet is comprised between thirty-three and thirty-five hours, or in the mean thirty-four hours. It does not appear to be possible to admit a duration of eighty-eight days for the rotation period.

Nova Aurigæ.—Prof. W. W. Campbell publishes some spectroscopic notes in the *Astrophysical Journal* (No. 4, vol. v.), among which are some relative to the new star that appeared in 1892 in Auriga. The observed intensities of six of the principal bright lines up to October 6, 1896, were as follows:—

	Hγ	λ4360	Hβ	λ4960	λ5010	λ5750
1892 Aug. and Sept.	0·1	0·8	1	3	10	1
1894 May 8	0·1	0·3	1	3	10	0·4
1894 Sept. 7	0·1	0·2	1	3	10	0·4
1894 Nov. 28	0·1	0·1	1	3	10	0·3
1896 Aug. 15	—	—	1	3	10	0·1
1896 Oct. 6	—	—	1	3	10	0·1

It will be noticed that the bright lines 4360 and 5750 have gradually diminished in intensity, the latter being scarcely visible at the last observation. These lines, it may be remarked, were strong in the Nova, but faint in the old nebulæ. Their gradual disappearance indicates that the return of this Nova to the nebula stage has been reached, "it is now of the ordinary type of nebular spectrum, save that the lines remain broad, as they have always been described." When the question as to the actual visibility of the nebula after the spectroscopic evidence of its truly nebular character came to be inquired into, several observers found that its appearance was not like that of a star of the same magnitude; while Prof. Barnard announced that the object was "really a bright nebula with a 10th magnitude nucleus." Prof. Campbell, estimating the magnitude of the Nova by comparing the length of its spectrum with that of a star of equal magnitude, came to the conclusion that "the focal image of Nova Aurigæ is stellar."

THE SIMPLON TUNNEL.

THE project of a tunnel through the Simplon has been so much discussed and so frequently abandoned, that one might almost doubt whether the scheme last suggested will ultimately prove effective. But the present plan has been brought to a more forward stage than on any previous occasion; the requirements of interested Governments have been met, the pecuniary difficulties seem to have been overcome, and, finally, contracts have been signed with an eminent firm of engineers, whose name is a guarantee that what is undertaken will be performed. We may, therefore, confidently expect in a short time to hear that this arduous work has been commenced; and it is scarcely premature to glance at the various problems, physical, mechanical and economical, that have had to be solved, or to express a hope that the solutions which have been offered, based as they are on varied experience, will prove adequate to cope with the many difficulties that will arise.

The economical problem can be easily dismissed. The advantages of the Simplon route are so patent, that the perforation of the mountain was suggested in the early days of railway enterprise, at a time when the difficulties that the Alps presented to continuous traffic were more fully apprehended than were the means by which those difficulties were to be surmounted. It is a very easy thing to put down on paper the number of miles that separate, say, London from Brindisi, and show that the train mileage is less by way of Simplon than either by Mont Cenis or Saint Gothard; and yet both these routes have been opened to traffic before the most advantageous line has been begun. If we select some station, as Plaisance, on the eastern side of the Alps, and directly on the Brindisi route, we have the following distances, according to the course followed:—

From London, Calais, Paris, *Cenis* to Plaisance,
1438 km. = 894 miles.
From London, Calais, Bâle, *Gothard* to Plaisance,
1375 km. = 854 miles.
From London, Calais, Reims, *Simplon* to Plaisance,
1253 km. = 779 miles.

But this saving of distance, amounting as it does to near 8 per cent., does not express the whole of the advantag that a route through the Simplon would offer. This last tunn being at a much less elevation above the sea-level than eithe of the others, the speed of the trains would be greater, and n special precautions needed to ensure the safety in passing ov inclines rather steeper than are usually experienced on frictio railways.

The maximum height of the			Simplon tunnel is	706	m.
,,	,,	,,	Gothard ,,	1155	,,
,,	,,	,,	Mont Cenis ,,	1295	,,
The Arlberg railway is the highest of all, being				1311	m.

To balance the economy of distance and small altitude, we have to consider the length of tunnelling necessary, and unfortunately the length required is in the inverse proportion to the conveniences of the route. The first-made tunnel, that of Mont Cenis, is 12,849 m. long, the Gothard 14,984 m., while that of the Simplon is computed at 19,731 m., so that the ratio of the first is to the third as 2 : 3.

The geological conditions have been well studied, and it will be interesting to compare the forecast framed from an examination of the external appearance of the mountain with the character and extent of the rocks actually encountered. On the south side, for a distance of about four miles, the principal rocks will be clay and mica slate with gneiss. In the central portion, extending over something like six miles, the boring tool will hav to work its way through gneiss, alternating with mica schist and limestone. On the northern side, towards the Rhone, slat and beds of gypsum will form the principal constituents; and here, though the rocks may not be so hard as in the centre of the mountain, greater difficulty is anticipated owing to the extreme precaution that will have to be taken in protecting the sides of the tunnel. The direction given to the perforation will make the axis of the tunnel practically perpendicular to the various seams.

If the extent and hardness of the rock were the only physical difficulties with which the engineers had to contend, doubtless the boring would have been attempted long since; but another, and a greater obstacle has to be overcome in the temperature of the rocks themselves. To excavate under a mountain is to some extent comparable with sinking a mine; and recalling the comparatively low altitude at which the tunnel is to be constructed, and the consequent height to which Monte Leone will tower above it (more than 2000 m.), it is evident that a pretty deep mine is contemplated. We are going to learn something of the internal heat of the earth at a considerable distance from the surface. One can make a pretty shrewd guess at what these temperatures will be, from previous experience in the Cenis and Gothard tunnels; and evidently the advantage of keeping the tunnel nearer to the sea-level, which will facilitate traffic, is accompanied with the disadvantage of having a greater mass overhead, and consequently greater heat. In the case of the Gothard, an increase of depth of 44 m. occasioned a rise in the temperature of 1° C. On this hypothesis, which is of course rough and approximate, in the middle of the work the thermometer will read about 40° C. In the Cenis the maximum temperature reached was 29° C.; but the workmen had to submit to this temperature for a short time only. In the Gothard the temperature of 31° C. had to be contended with for a long distance, and the sufferings were proportionately severe. Anæmia and kindred diseases played havoc with the work-people. Some 60 per cent. of the workers, it is reckoned, were attacked; and to prevent a similar disaster in the present undertaking, another set of problems, dealing with ventilation and sanitation, had to be considered as part of the entire mechanical difficulties that present themselves.

The lines along which the main engineering problem has been solved are tolerably well known. The scheme contemplates the construction of two parallel tunnels, whose axes will be separated by 17 metres. These two parallel roads will be connected at regular intervals by transversal galleries leading from one to the other, capable of being closed at will by air-tight doors. Only one of the main tunnels will at present receive its final dimensions, and be fully finished for traffic. The breadth will be 5 m., and the height above the sleepers 5·5 m. These dimensions will permit only a single line of rails to be laid, and provision is made in the middle of the tunnel for a siding 400 m. long, so that two trains may pass in opposite directions. The object of the second tunnel, which will have a section of eight square metres, is mainly to ensure sufficient ventilation, and, indeed, to make the work in the main gallery possible. It was this ingenious thought, of carrying along simultaneously the two galleries, which has brought the perforation of the Simplon within the range of possibilities. This suggestion is due to Herr Brandt, of the firm with whom the contract has been placed. The distinguishing feature of this proposal is that it will ensure a current of air passing through the entire system of the tunnels. Evidently, if ventilating apparatus be placed at the entrance of either gallery, a current of air can be forced through one tunnel, through the transverse gallery at the end of the working (all the intermediate openings being closed), and out through the other tunnel. If it be objected that the construction of the second gallery is a very expensive method of supplying fresh air to the workpeople, the answer is that, without some such means, the perforation is found to be impracticable. But the expense is not so great as it seems, because the second gallery can at no very great additional cost be made available for traffic when this increases to such an extent as to make the single line first laid insufficient. It is proposed to supply through this supplementary tunnel 50 cb.m. of air per second, by means of a current moving with the velocity of 13 miles an hour. Such a supply is far in advance of the quantity available at the Saint Gothard workings, and is to some extent founded on the amount that is found necessary to ventilate the Mersey tunnel. In this latter case the supply of fresh air, which no one who has made the journey from Birkenhead to Liverpool would say is excessive, is, it is true, four times greater than the quantity that will be pumped into the Simplon passage; but the number of trains that pass in a day is considerably more, under the Mersey, than will be the case in the Simplon passage. Such a current may, therefore, be sufficient for the workmen, and will certainly tend to reduce the high temperature; but the engineers will not trust to this means alone, to make the interior of the cutting endurable. Recourse will be had to the distribution, throughout the workings, of fine water-dust under considerable pressure. If the water, as it is hoped, can be delivered at the rock face at a temperature of 12° C., it can be employed with the happiest effect. Experiments made at Winterthur, before a committee of experts, proved that an air temperature of 40°—50° C. could be lowered to 15° by employing a water-dust of 12° C. under a pressure of five and a half atmospheres. When higher pressures are available a still more marked result is produced, and the abundant supply of water at both ends of the tunnel will permit this method to be tried under very favourable circumstances.

This large supply of water, from the Rhone on the north side, and from Italian streams on the south, very fortunately permits the use of hydraulic machinery as a means of economically working the boring apparatus. In other works of similar character, compressed air has been the agent employed, against the use of which some objections have been urged. We have here, therefore, the means of comparing the efficiency of the two methods, both in the operation of cutting through the hard gneiss rock, and the effect on the health of the operators, on whom the escape of the compressed air is said to work disadvantageously. On the Arlberg, the natural surroundings of which are comparable with those to be met on the Simplon, the Brandt hydraulic perforating machine has given great satisfaction. It is contended by its supporters that, in a work of such magnitude, where the power has to be supplied from a great distance, that hydraulic transmission is to be preferred to all other, because with it the loss of force is the least. From actual experiment on gneiss rock, it has been shown that a perforation 1 m. deep and 70 mm. diameter can be bored in 12 to 25 minutes, and that consequently a daily advance of 5·85 m. can be reckoned upon. That M. Brandt has the greatest confidence in his invention and in his methods is shown by the fact that, in the contract which he has signed, he is willing to submit to a fine of 5000 francs a day in case the work is not completed in the five and a half years he allows himself. The total cost of the entire construction is computed at less than 3,000,000*l*. It is interesting to compare the rate of progress and cost of construction of the three tunnels which will compete for the Trans-Alpine traffic. In the case of the Mont Cenis tunnel, which represents the state of mechanical science some thirty years since, a year, approximately, was required to complete each kilometre at a cost of six millions of francs. The Saint Gothard, about ten years later in date, proceeded twice as rapidly, while the cost of construction dropped to four million francs per kilometre. Herr Brandt, however, proposes to complete four kilometres per annum, at the same time reducing the expense per kilometre to one half that of the earliest tunnel. One may well wish that this sanguine estimate will be justified.

ON THE COLOUR AND COLOUR-PATTERNS OF MOTHS AND BUTTERFLIES.

A PAPER by Mr. Alfred Goldsborough Mayer, on "The Colour and Colour-Patterns of Moths and Butterflies" (*Proceedings* of the Boston Society of Natural History, vol. xxvii. No. 14, pp. 243–330, March 1897), is a rather elaborate discussion of a subject which has lately attracted much attention; but though Mr. Mayer has made some interesting experiments and observations, his results are neither so novel nor so important as he claims them to be. One of the most interesting parts of the paper is the account of the development of wing-colours during the pupal state, a summary being given of previous researches, supplemented by a series of new observations on common species of American moths and butterflies. The result arrived at is, that the wings are at first transparent, then white, then drab or dusky yellow, while all the purer and brighter colours arise later on. This is what might be expected from the general distribution of colour in lepidopterous insects, and has been indicated by Dr. Dixie and other writers as probable.

Some ingenious experiments were made for the purpose of ascertaining whether the wing-scales were of any use in giving a greater hold on the air. The wings, with and without scales, were attached to a delicate pendulum, but no measurable difference in air-friction was found. Neither do the scales perceptibly strengthen the wings, hence it was concluded that they have been developed solely as colour-producing organs of use to the various species.

A considerable space is devoted to the development of the colour-patterns of the Danaoid and Arcræoid Heliconidæ and the phenomena of mimicry. These are illustrated by four coloured plates intended to show the markings of a large number of species. These plates do not represent the insects themselves, but are "projected by Keeler's method" on rectangles of uniform size, which are supposed to afford more accurate means of comparison. This will seem to most naturalists to be a great mistake. It not only renders the patterns of the most familiar species almost unrecognisable, but it introduces many possibilities of error in the process of projection which even a comparison with the species represented may not enable us to detect. In the case of mimicking species it has the further disadvantage of obscuring differences of outline, and by irregular distortion giving undue prominence to what may be very slight differences in the actual species. In many mimicking species there is a wonderful similarity of general effect combined with considerable differences of detail, and by the process of "projection" these differences of detail may be exaggerated while the general similarity is obscured.

While accepting Fritz Müller's explanation of the mimicry of protected species by each other, and as also affording the only intelligible reason for there being only two types of colour-pattern in the whole 400 species of the Danaoid Heliconidæ, he says that "unfortunately no *direct* experiments have been made on the feeding habits of young South American birds." But in view of the careful experiments of Prof. Lloyd Morgan on a variety of young birds this is hardly necessary, as it is proved that they have in no case any instinctive knowledge of what is edible or distasteful, while they acquire the knowledge by experience with extreme rapidity. Like many other writers on the subject who have recently criticised and rejected the theory of warning colours as indicating inedibility, Mr. Mayer does not distinguish between the *habitual* and the only *occasional* enemies of protected insects. Thus he refers to the experiments of Beddard, showing that toads will eat any insects whatever; but it is quite certain that toads are not very dangerous enemies to either butterflies or their larvæ, nor probably are marmosets, which are also general feeders. There is quite sufficient evidence to show that insects with warning colours *are* rejected by most insectivorous birds and lizards, which are certainly the most general and most dangerous devourers of insects both in the larva and winged state, and these facts, taken in conjunction with the experiments of Prof. Lloyd Morgan, afford a firm foundation for the whole theory of warning colours and mimicry.

A. R. W.

THE PRIMATE BRAIN.[1]

THE comparative study of the convolutions of the brain surface in man, apes and monkeys, may be said to have been founded by Gratiolet, who mapped out the fissures in the lower monkeys, traced the patterns upwards through the apes to man, and invented a system of names for the convolutions. In recent years this study has received impulse from two distinct causes: on the one hand, the greater opportunity of examining the brains of the higher apes; and, on the other, the attempt to locate in the convolutions definite functions has led to experiments being conducted, by physiologists and psychologists, upon the brains of monkeys. A great variation in the convolutions of species of monkeys and of apes has been thereby shown to exist, and more accurate data have been rendered available for a true morphological comparison with those of man; and although the subject has, to a very great extent, been attacked from a physiological standpoint, yet the morphology of the convolutions has received increased attention during the past few years, notably at the hands of Dr. Cunningham, whose careful and extended work on this subject covers a good deal of the ground opened up in the present memoir, which deserves a place alongside that of the Dublin anatomist.

The publication of Dr. Parker's work, which was communicated verbally, to the Academy of Philadelphia, as long ago as 1890, has been delayed till last year, owing to a variety of circumstances—amongst others, the death of the author in 1892. After an introduction dealing with the scope and aim of the memoir, there follows an interesting historical survey of the observations and opinions of the chief writers on the subject. The author then tabulates the names of the fissures and convolutions applied to the human brain, with their synonyms as employed by each author. This table will be of considerable value to students of the subject, as will be the historical survey.

How are these convolutions and furrows on the surface of the brain brought about? What is the cause of the gyrencephalous condition? This is still a matter of controversy. To this question two chief, but opposing answers have been suggested, each supported by equally competent authorities. The one school looks on these convolutions as due to the effect of pressure of the slowly growing skull on the more rapidly growing brain. The opposite school believe the cause to be innate—that is to say, the convolutions owe their origin to differential growth in certain definite regions of the brain surface itself. Dr. Parker combines these two opposing views: believing that certain "fundamental fissures" are produced by mechanical causes, whilst others owe their origin to morphological processes of growth in the brain substance; the fissures, of course, representing lines of retarded growth. During early development, it is the brain which modifies the shape and structure of the skull, rather than the reverse; ultimately, as the skull grows more rigid, its influence is shown in the increasing tortuosities of the folds.

The development of the human brain is traced out, so far as is necessary to explain the author's views, and the various stages are compared with the adult brain of monkeys. At the age of three months the fœtal human brain consists of three lobes, which he terms the "occipito-frontal," "occipito-temporal," and "occipital." It does not immediately appear evident why the author employs compound names for the two former lobes, unless it be to insist as strongly as possible upon the fact that there is no such thing as "parietal lobe," at any rate as a morphological equivalent of the others. The "island of Reil" is not homologous with a "lobe," but is developed at the bottom of a depressed area, the *fossa sylvii*. Each of the three lobes contains a portion of the lateral ventricle; each will exhibit a similar, and symmetrical series of furrows. He points out here, as elsewhere, that the "occipital" lobe, developed as it is round the posterior cornu of the lateral ventricle, is peculiar to the Primates.

During the third month a certain number of "temporary furrows" make their appearance on the surface of the hemispheres; they radiate from the region of the sylvian fossa, and when viewed from the mesial surface, lines drawn through all but those in the occipital lobe meet at a centre which lies in the cerebral peduncle: and the angle included between any two neighbouring lines is constantly 60°, or thereabouts. This fact he makes use of in considering the causes concerned with the production of these fissures, which he attributes to pressure between brain and skull.

But, as is well known, these temporary fissures disappear, and the brain again becomes smooth for a short time at about the fifth month; and he lays great stress on this smooth brain, with its three lobes, a sylvian fissure, a calcarine fissure, and "mesial arched fissure." The author regards this stage as the fundamental plan of the Primate brain; indeed, this is essentially the marmoset's brain enlarged. Later on, new fissures appear, and he recognises, in addition to the (1) fundamental or primary fissures, just mentioned, the (2) secondary fissures, (3) sulci of Pansch, mere vegetative repetitions of (2); (4) sulculi, which are inconstant, and (5) rami, which are the branches of (2) or (3). The mesial arched fissure gives rise to the callosal and the hippocampal fissures; each of which, with the calcarine, is similarly related to one of the three primary lobes.

The occipital lobe next becomes definitely marked off from the rest by two fissures, a dorsal and a ventral, constituting the "primary occipital arch." The dorsal one is the "parieto-occipital" or "perpendicular fissure" of monkeys. The mesial ends of these are symmetrical with regard to the calcarine. These fissures, again, are regarded as being due to pressure.

This stage represents the characteristic Simian brain (including that of man).

Parker disagrees with the usual view, that the *fissure of Rolando* is a primary fissure; nevertheless, it is certainly characteristic of the primate brain, for it occurs in no other order. He explains the fissure in an ingenious manner, by reference to a lemur's brain, in which there are two longitudinal fissures extending along the fronto-occipital lobe; a part of the upper one is supposed to become vertical. But no ontogenetic evidence is forthcoming for this view, which would lead us back readily to the condition of a carnivore's brain.

It is impossible to give briefly his many interesting suggestions as to the homologues of the frontal and parietal convolutions; but special interest will be taken in his account of the occipital convolutions, for these have always troubled anatomists, who have until recently regarded them as being more or less irregularly arranged, and consequently have neglected them. Parker endeavours to show that they can be reduced to order, especially if the development of the "plis de passage" or "annectant gyri" be taken into account. These rise up, as I have shown in discussing the brain of the chimpanzee "Sally," and as others have also shown, from the bottom of fissures; so that in one brain they may be hidden, in another they come to the surface and divide single fissures into two. Parker says: "The typical fissures represent the lines of least resistance to the differential action of the pressure forces.

[1] "Morphology of the Cerebral Convolutions, with special reference to the Order of Primates." By Andrew J. Parker, M.D. *Journ. Acad. Nat. Sci. Philadelphia*, 2nd series, vol. x, 1896, pp. 247 to 362; with fifteen plates and several figures in the text.

. . . As development proceeds, and the skull begins to assume a more fixed and rigid shape, new conditions and relations of the growth forces take place, as a result of which those portions of the cerebral surface lying in the depths of some of the fissures, originally produced by depression, are placed under new dynamical conditions; instead of being situated as formerly along the lines of resolution of greatest pressure and least resistance, they become centres of relatively greatest growth force as compared with the resolution of pressure forces." Hence they rise up as annectant gyri. To these interesting, and at one time puzzling, features he devotes some pages.

He gives a very brief, and second-hand, account of the convolutions in Carnivora and Ungulata, rightly insisting that it is impossible to homologise these fissures, one by one, with those of Primates' brains; for, even between ungulate and carnivore, it is only possible to compare groups of fissures. This fact is gradually becoming more and more fully recognised; and in mounting a series of brains for the Oxford Museum, I have purposely indicated the fissures in the ungulate, for example, and the Primate brain, by means of entirely different sets of colours. There is a type of convolution for each order, these types being derived, not one from another, but independently for a smooth-brained condition; a view which accords with palæontological evidence. Nevertheless, there is more community between the Ungulata and the Carnivora, in this matter, than between other groups.

Finally, the author discusses the "Mechanics of the formation of cerebral fissures," and brings to bear on the subject (*a*) the theory of the formation of films in soap-bubbles, propounded by Plateau; and (*b*) the facts of surface tension as put forward by Maxwell. This part of the paper is illustrated by numerous formulæ and diagrams; but I imagine most anatomists will pass these by. If for surface tension of films we substitute the pressure forces produced by cerebral swellings aggregating round certain centres, then the peripheries, meeting each other within a confined space, produce the lines of fissuration.

The memoir, interesting as it is, would have been rendered more valuable by the addition of a bibliography; references are, indeed, given here and there in footnotes, but they are scarcely worthy of the work.

The figures, again, copied as many of them are from various sources, are variously lettered; there is practically no "explanation" of plates, and some of the figures, which are mere outline drawings without shading, represent the brain in oblique directions, which it is very difficult to follow, as no indication of these directions is given in the list of figures.

W. B. Benham.

LECTURE-ROOM DEMONSTRATION OF ORBITS OF BODIES UNDER THE ACTION OF A CENTRAL ATTRACTION.[1]

NOT remembering to have seen any attempt to show experimentally in the lecture-room the motion of bodies acted on by a central attractive force varying inversely as the square of the distance in elliptic, parabolic and hyperbolic orbits, I have made a few experiments with a view of determining how well these curves could be imitated by the motion of a small steel ball around a magnetic pole. The results were so good that I feel warranted in making them known, and believe that the experiment may be found useful in making more cheerful that portion of the course usually rather destitute of pyrotechnics.

The apparatus used was very simple, consisting of a circular glass plate about 40 cm. in diameter, with a small hole in the centre, through which projected the somewhat conical pole-piece of a large electro-magnet (Fig. 1). The surface of the plate was smoked, and it was made level as nearly as possible, the axis of the magnet being of course vertical.

A small, highly-polished ball of steel about 5 mm. in diameter (from a bicycle bearing), when projected across the plate, traced its path in the soot, and left a permanent record of its motion.

Under these conditions gravity exerts no direct influence on the motion, and we have only the initial velocity and the central attractive force to deal with, together with the loss of velocity due to friction. There are several other circumstances which make the conditions unlike those existing in the case of two gravitating bodies in space, and, taking everything into consideration, it is quite surprising what good results were obtained.

The ball was blown out of a short piece of glass tubing held in the plane of the plate with varying initial velocities, and curved orbits obtained, which were, at least, good imitations of the ellipse parabola and hyperbola.

Fig. 2 is a photograph of a plate showing all three forms, the white spot in the centre being the hole occupied by the magnet pole; the arrows indicate the direction of the motion.

No. 1 was produced with low initial velocity, and is a very fair represention of an ellipse, with the attractive force in

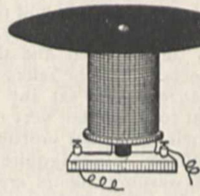


Fig. 1.

one focus. The loss of velocity due to friction caused the ball to "fall into the sun" after completing one revolution, a one year's existence of the system.

On another trial an ellipse (*spiral*, strictly speaking) was obtained that was almost re-entering, the miss being not more than a couple of millimetres, while in the one figured it was nearly a centimetre.

The right-hand branch of No. 2 resembles a parabola, and was produced by a somewhat higher initial velocity. It will be noticed that the ball moved to its perihelion position in a path rather like a hyperbola, and on rounding the pole, its velocity having been diminished somewhat, moved off in a

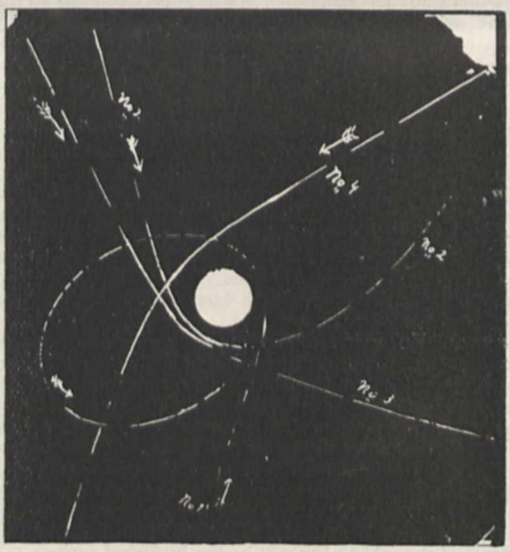


Fig. 2.

parabola. It would be more exact, probably, if we called this curve an ellipse of great eccentricity, since the conditions governing the formation of a parabolic orbit would be difficult even to approximate.

No. 3 and 4 are hyperbolæ, produced by still higher initial velocities.

None of the orbits shown in the figure are as perfect as some that have been obtained by accident on other plates. It is very difficult to make a plate showing all three forms with only four or five trials, as the velocity has to be nicely adjusted; consequently, the curves shown in the figure must not be taken as samples of the best that can be produced by a large number of trials.

[1] Reprinted from the *Physical Review*, with supplementary note by the author.

The hyperbola is, of course, the easiest to produce, and the parabola the most difficult. Some device for regulating the initial velocity and aim would be conducive to more uniform results.

Polarisation of the steel ball is apt to give trouble, and I have obtained some repulsion orbits where the ball turns back before reaching the centre, which are very pretty, but not desirable when one is trying to illustrate central attraction. Soft

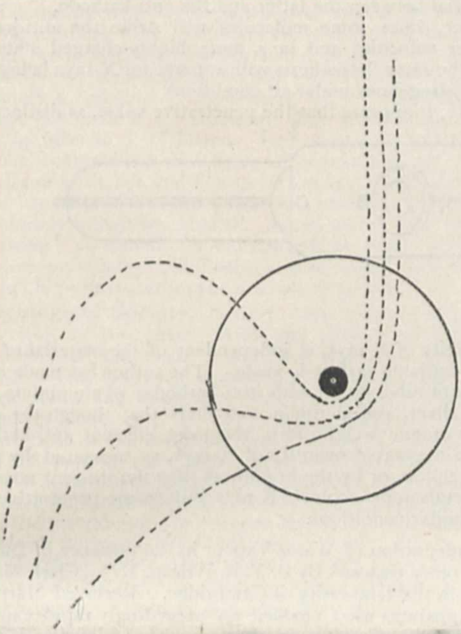


FIG. 3.

iron balls would be preferable to steel on this account; but they are not on the market, so far as I know, and the others answer the purpose well enough.

[*Supplementary Note.*—With a very powerful Rhumkorff magnet, belonging to the Massachusetts Institute of Technology, I have caused the ball to gyrate in a vertical plane about the poles, notwithstanding the perturbating influence of gravity. This elimination of the supporting plane makes the conditions

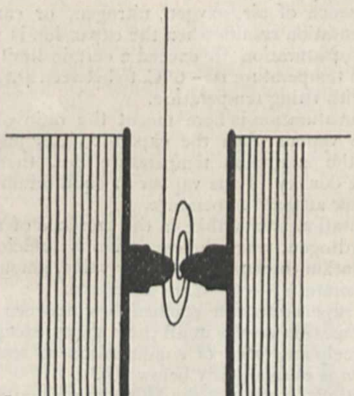


FIG. 4.

a little more like those existing in the case of plantetary bodies moving in space; but the motion is so rapid that it is difficult to see the form of the curve, and no permanent record is left: moreover, the curves are distorted by the downward pull of gravity.

The two conical pole-pieces of the magnet were brought close together, creating a very intense field, and the ball was dropped from elevations varying from six inches to a couple of feet at different distances from the vertical plane joining the poles. Usually the ball flies either directly to the poles, or moves in a path similar to some one of those shown in Fig. 3 (the pole being seen end on); but on several occasions I have succeeded inducing it to perform two or three complete revolutions, as shown roughly in Fig. 4.] R. W. WOOD.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Sidney Colvin has been appointed by the Council of the Senate a Trustee of the British Institution Scholarship Fund, in the room of the late Prof. Middleton.

The subject for the Adams Prize for 1899 is "The Theory of the Aberration of Light." The prize is open to all graduates of the University. Essays must be sent to the Vice-Chancellor by December 16, 1898. The value of the prize is about 200*l*.

Sixteen candidates have passed the examination in Sanitary Science, and will receive the University's diploma in Public Health.

The annual prize for an essay on an archæological subject offered by Newnham College has been this year awarded to Miss R. E. White (first class, Classical Tripos, 1895); the subject was "Women in Egypt under the Ptolemies."

It is understood that the syndicate on degrees for women, whose report was referred back to them for reconsideration, have agreed to adhere to their recommendations. The voting on the scheme in the Senate is expected to take place about May 20. An active canvass for and against their proposals is being conducted by Committees in Cambridge and London.

IT has been decided to transfer the administration of the grants to schools in Scotland for science and art to the Scotch Education Department. The details of the transfer will be a matter of departmental arrangement.

THE Legislature of the State of New York has passed a Bill authorising the appropriation by New York City of two and a half million dollars for the purpose of erecting the new public library to be built on the corner of Fifth Avenue and West Forty-second Street, and the Mayor has approved the Bill; so that the city is pledged to execute the work.

THE following gifts and grants to educational institutions in the United States are announced in *Science*:—The Sheffield Scientific School of Yale University receives 25,000 dollars by the will of Mrs. Sarah Van Nostrand.—The department of natural history of Vassar College will receive about 25,000 dollars through the settlement of the will of the late Jacob P. Giraud.—A Bill before the Texas Senate appropriates for the State University 35,000 dollars for 1897 and 85,000 dollars for 1898, and in addition 42,000 dollars annually for the medical department.

SOCIETIES AND ACADEMIES.

LONDON.

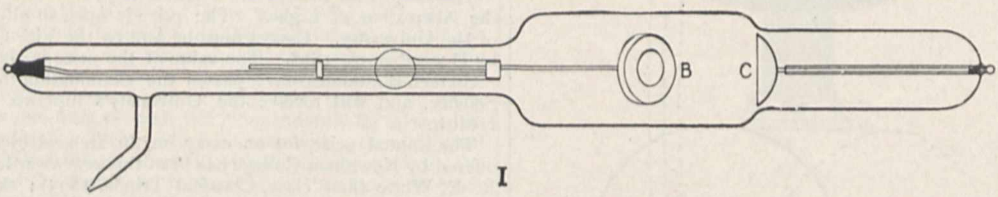
Royal Society, April 8.—"The Production of X-Rays of Different Penetrative Values." By A. A. C. Swinton. Communicated by Lord Kelvin. Received March 24.

If the X-rays coming from a focus tube of the ordinary type be observed with a fluorescent screen during the process of exhaustion, the penetrative value of the rays is found to change as the exhaustion proceeds. At less than a certain degree of vacuum, no X-rays are produced. As the vacuum increases, X-rays commence to show themselves, but of a quality that will do little more than penetrate the backing of the screen. At higher vacua the rays become more penetrative, and show the shadow of the bones of the hand. The point is next reached when the flesh of the hand is very transparent, while the bones are still quite opaque. At higher vacua than this, the bones become more and more transparent, till at length, at the very highest vacuum at which the discharge will pass, the bones become nearly as transparent as the flesh, while the whole hand throws but a very faint shadow on the screen.

Similar effects can be produced with a constant vacuum by gradually increasing the power of the Rhumkorff coil, or by varying the resistance of the tube by means of a magnetic field, the X-rays being most penetrative with great electrical power and high resistance in the tube, and least penetrative with low electrical power and low resistance.

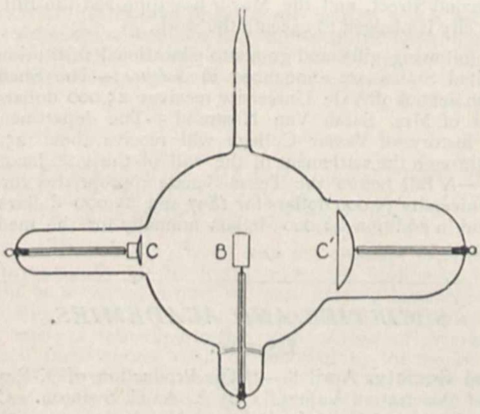
The author has further found that it is possible to vary the penetrative value of the X-rays produced by a focus tube, by simply altering the distance between the kathode and anti-kathode.

Fig. 1 shows such a tube, in which the anti-kathode B of aluminium, faced with platinum, is connected to the anode terminal by a sliding steel rod, so that it can be moved along the axis of the tube; and the distance between the kathode C and the anti-kathode B varied from 1 to 3 inches. With such a tube, exhausted so as to give X-rays of medium penetrative value, with the anti-kathode midway between its two extreme positions, if the anti-kathode be now placed nearer to the kathode, the X-rays immediately become of a higher penetrative value, just as though the vacuum had been increased; while again, when the anti-kathode is moved in the opposite direction, and placed at a greater distance from the kathode, the X-rays become less penetrative, and similar to those produced at a lower vacuum. In this way, without varying the vacuum, the penetrative value of the X-rays can be increased or decreased within limits, as desired.



I

Again, the author has found that the penetrative value of the X-rays can be altered by employing kathodes of different diameters. In the tube shown in Fig. 2, there are two kathodes, C and C′, both focussing upon opposite sides of the same anti-kathode B. The kathodes are of dissimilar diameter, C′ being about twice the diameter of C. If a tube of this type be exhausted to the degree necessary to give rays of medium penetrative value with the smaller kathode, and the connections are then altered so as to bring the larger kathode into operation, the X-rays are immediately found to have become of very low penetrative value. If the vacuum be then increased so that, with the larger kathode in use, X-rays of medium penetrative value are obtained, it will then be found that with the smaller kathode X-rays of much higher penetrative value are produced.



II

In all the above-mentioned experiments the author has found that the conditions which produce X-rays of high penetrative value are also the conditions that produce a considerable potential difference between the anode and kathode portions of the tube, and at the same time a high electrical excitation of the kathode.

On the assumption that kathode rays consist of negatively charged molecules that are repelled from the similarly electrified kathode, with an initial velocity that depends upon the degree of electrical excitation of the kathode, the conditions which, as above mentioned, produce X-rays of high penetrative value, are those that would conduce to a high average velocity of the molecules at the moment at which they strike the anti-kathode, and at the same time to a high average difference of potential between the travelling molecules and the anti-kathode at the moment of impact. Conversely the conditions which produce X-rays of low penetrative value, are such as would conduce to a lower average velocity of the molecules, and to a less difference of potential between the latter and the anti-kathode.

Further, since some molecules will strike the anti-kathode at higher velocities and in a more highly-charged state than others, the same hypothesis will account for X-rays being more or less hydrogenous under all conditions.

Finally, it appears that the penetrative value, as distinct from the quantity of X-rays, is independent of the material of which the anti-kathode surface is made. The author has made experiments with tubes fitted with anti-kathodes of aluminium, iron, copper, silver, and platinum, and finds that though the metals of high atomic weight form the most efficient anti-kathodes, and give a greater quantity of X-rays, as measured by photographic action, or by the brightness of a flurorescent screen, all these metals appear to give X-rays of the same penetrative value under similar conditions.

"Condensation of Water Vapour in the presence of Dust-free Air and other Gases." By C. T. R. Wilson, M.A., Clerk-Maxwell Student in the University of Cambridge. Received March 15.

The apparatus used enabled an exceedingly rapid expansion of any desired amount to be effected. The following is a summary of the results obtained.

If air, initially saturated and free from foreign nuclei, be allowed to expand suddenly, a rainlike condensation results if the ratio of the final to the initial volume v_2/v_1 exceeds 1·252; no condensation taking place except on the walls of the vessel with smaller expansions.

The number of the drops produced remains small if v_2/v_1 does not exceed 1·37. Beyond this point the number increases at an exceedingly rapid rate with increasing expansion, the cloudlike condensation which then results showing colour phenomena of a very definite kind.

In the presence of air, oxygen, nitrogen, or carbonic acid, rainlike condensation results when the expansion is sufficient to cause the supersaturation to exceed a certain limit amounting when the final temperature is $-6°$ C. to between 4·2 and 4·4, and diminishing with rising temperature.

By the supersaturation is here meant the ratio of the actual density of the vapour when the expansion has just been completed, and the minimum temperature has, therefore, been reached to the density of the vapour in equilibrium over a flat surface of water at that temperature.

The condensation is cloudlike in the presence of any of these gases or of hydrogen, when the expansion is sufficient to cause the supersaturation to exceed a certain value, amounting, when the final temperature is $-16°$ C. to about 7·9.

When the supersaturation reached lies between these limits rainlike condensation results in all these gases, except hydrogen, in which scarcely any trace of condensation is seen when the supersaturation is even slightly below 7·9.

A statement of the effect of the Röntgen rays on condensation in the presence of air has already been published. They cause a great increase in the number of the drops produced, the minimum expansion required to cause condensation being, however, unaltered. When hydrogen is substituted for air their effect is similar, the nuclei introduced by the action of the rays requiring the supersaturation to reach the same limit as is required for rainlike condensation in air, in order that condensation may take place upon them.

Chemical Society, March 25.—Mr. A. G. Vernon Harcourt, President, in the chair.—Prof. P. Frankland delivered the Pasteur Memorial Lecture (see p. 518).

March 31.—Anniversary Meeting.—Mr. A. G. Vernon Harcourt, President in the chair.—The Longstaff medal was presented to Prof. W. Ramsay, for the discovery of helium and for his share in the investigation of argon. After the reading of the President's address, the ballot for the election of Officers and Council for the ensuing year was held.

April 1.—Prof. Dewar, President, in the chair.—The following papers were read:—The hydrolysis of perthiocyanic acid, by F. D. Chattaway and H. P. Stevens. Perthiocyanic acid is readily hydrolysed by water at 200° or by heating with strong sulphuric acid, thiourea, carbon oxysulphide and sulphur being produced; the thiourea found amongst the products of the action of strong sulphuric acid on potassium thiocyanate is certainly a product of hydrolysis of the perthiocyanic acid always produced in the reaction.—The composition of cooked fish, by Miss K. I. Williams. Determinations have been made of the constituents and heats of combustion of twenty-two species of fresh fish and five species of preserved fish and oysters after cooking. On the oxidation products of $\alpha\gamma$-dimethyl-α'-chloropyridine, by Miss E. Aston and J. N. Collie. On oxidising $\alpha\gamma$-dimethyl-α'-chloropyridine with permanganate α-chloro-γ-methyl-α'-pyridinecarboxylic acid and α-chloro-α-methyl-α'-pyridinecarboxylic acid are obtained.

Geological Society, April 7.—Dr. Henry Hicks, F.R.S., President, in the chair.—After the election of Fellows, the President left the chair, which was taken by Prof. Bonney, F.R.S.—The following communications were read:—On the Morte slates and associated beds in North Devon and West Somerset (Part ii.), by Dr. Henry Hicks, F.R.S.; with descriptions of the fossils by the Rev. G. F. Whidborne. In the first part of this paper, read by the author before the Society in February 1896, he described the Morte slates as they occurred in North Devon, and the fossils found in them. In this, the second part, he referred mainly to the rocks classified as Morte slates in West Somerset. The author contended that the Morte slates which extend through the centre of North Devon and West Somerset from Morte Point to the north of Wiveliscombe, a length of about forty miles, are the oldest rocks in the area and formed an axis with newer rocks lying to the north and to the south. In the discussion which followed the reading of the paper, Mr. Etheridge said he could not agree with the author upon the important question at issue, either as to the stratigraphical or palæontological evidence afforded by the Morte slates justifying the assertion that they were "the oldest rocks in North Devon"; and he differed entirely from the author in the conclusions drawn, as based upon this assertion. Prof. Hughes thought that, taking the difference of sediment and other circumstances which tended to modify the distribution of life, no sufficient evidence had yet been offered to establish the author's principal contention. Mr. Marr remarked that the author had established one of his main contentions, namely, that the apparent succession in North Devon was not the true one. The Rev. H. H. Winwood remarked that whatever difference may exist in the two views as to the stratigraphy of the North Devon beds, yet one fact was indisputable, that the author had found fossils in the Morte slates which previous observers had failed to do. Mr. R. S. Herries said that he had been over part of the area with the author. He had not examined the south side, but he thought that on the north there could be no doubt that on stratigraphical grounds the Treborough slates belonged to a series entirely distinct from the beds immediately north of them. Dr. J. W. Gregory referred only to the palæontological questions, and not to the stratigraphical difficulties. He said the case for the Lower Devonian age of the fauna appeared, from the evidence quoted by the author, to rest on the *Cryphæus* (as the author preferred to call it) *laciniatus*. Dr. Hicks described this species as characteristically Lower Devonian; but it was commonest at the extreme top of the Lower Devonian, as in the Vichtian beds, where it was associated with Middle Devonian forms. Gosselet quoted it from the Eifelian (Middle Devonian), and asserted its occurrence in the Upper Devonian. Hence the speaker doubted whether it proved much. The author replied to the various criticisms, but held that they did not affect his conclusions.—The President then resumed the chair.—The glacio-marine drift of the Vale of Clwyd, by T. Mellard Reade. The local drift of the higher parts of the Vale of Clwyd is replaced by marine drift towards the mouth; and it was the object of this paper to give the results of a detailed examination of these marine drifts, rather than to explain the phenomena. The first part of the paper gave the results of an examination of the boulder-clay from Craig, west of Llandulas, to the Vale of Clwyd, south-east of Abergele. Mechanical analyses of the clays were given; but the point of greatest interest was the occurrence of abundance of foraminifera, especially in the plastic brown and red boulder-clays, which often contain intensely striated erratics. Mr. Strahan drew the attention of the author to Prof. Hughes's exhaustive papers on the drifts of the Vale of Clwyd. The occurrence of foraminifera was to be expected in clay so similar to that of Cheshire, in which they had long since been recorded by Mr. Shone. Prof. Hughes said that he had laid pretty fully before the Society his views as to the origin and classification of the drifts of the Vale of Clwyd (*Quart. Journ. Geol. Soc.*, vol. xliii., 1887, p. 73); and he gathered from the exposition of Mr. Mellard Reade's recent observations in that area, that the foraminifera which he had obtained all occurred in the newer or St. Asaph drift. This had all the characteristics of the shore-deposits on that coast at the present day.

Royal Meteorological Society, April 21.—Mr. E. Mawley, President, in the chair.—Mr. W. H. Dines read a paper on the relation between cold periods and anticyclonic conditions of weather in England during the winter. There seems to be a generally accepted belief that anticyclonic conditions during the winter are likely to be accompanied by exceptional cold; but, in so far as England is concerned, the author's observation has led him to the opposite conclusion, and he always expects a frost to break up as soon as the barometer gets much above 30·00 inches. To test the truth of this theory he tabulated the height of the barometer for all the cold periods during the three winter months of the fifty years 1841-90. Out of 74 frosts, he found that 16 only had a pressure exceeding 30·20 inches, and the majority of these were of very short duration. Thirty-three, or less than half, had a pressure exceeding 30·00 inches. Twenty-one had a pressure below 29·80 inches, and these included almost every frost in the period remarkable for its length or severity.—A paper by Mr. A. Lawrence Rotch, of the Blue Hill Observatory, Mass., was read, describing the use of kites at that observatory to obtain meteorological records in the upper air. Three kinds of kites have been used, viz. (1) the Malay kite, which presents a convex surface to the wind; (2) the Hargrave cellular kite; and (3) a flat kite with a fin or keel on the front, devised by Mr. Clayton. These kites are attached to a wire carrying self-recording meteorological instruments, and a steam winch automatically distributes the wire on the drum and records its pull. The instruments have been elevated more than one hundred times, and valuable meteorological data as to the changes of temperature, humidity, and wind up to an extreme altitude of 8740 feet above Blue Hill have been obtained.—A paper by Mr. A. B. MacDowall, on suggestions of sunspot influence on the weather of Western Europe, was also read. The author believes that there is a tendency to greater heat in the summer half-year, and to greater cold in the winter half-year near the phases of minimum sunspots than near the phases of maximum; the contrast between the cold and heat of the year thus tending to be intensified about the time of minimum sunspots.

PARIS.

Academy of Sciences, April 20.—M. A. Chatin in the chair.—On the classification of the Inseminеæ; the subdivision of the Unitegemineæ or Icacinineæ, by M. Ph. van Tieghem. A continuation of previous papers on classification.—Determination of the surface, stoutness, and chemical composition of the human body, by M. Ch. Bouchard. A series of formulæ is developed giving empirically the relations between the surface, weight, height, and girth. The factor varies with the sex, and also with the corpulency of the individual, the latter being defined by the ratio of the weight to the height.—Details of the methods employed in exact cryoscopical researches, by M. F. M. Raoult. The results of some experiments on the constancy obtainable for the convergent temperature are given, and the conclusion is drawn that it is comparatively easy to arrange matters so that the disturbing effect of the temperature of the refrigerant may be completely neutralised, the accuracy of the measurements taken with the precautions indicated being 0°·0005.—On the physiological action of the X-rays, by M. W. Crookes. The effects produced by the X-rays vary greatly with the idiosyncrasy of the experimenter, no evil effects having followed even prolonged exposure to the rays in the case of the author.—Comparison between the absorption by crystallised media of luminous rays and the Röntgen rays, by M. V.

Agafnoff. No sort of parallelism appears to exist between transparency to ultra-violet rays and the Röntgen rays, the sulphates, for example, being nearly opaque to the latter, although very transparent to the former. The reverse of this occurs with most crystallised organic compounds.—On dark light, by M. Perrigot. The results obtained by M. G. Le Bon, stated by him to be due to special rays, the "dark light," are shown to be capable of another explanation, the ebonite sheet used being itself slightly transparent to white light.—On the separation of chlorine and bromine, by MM. H. Baubigny and P. Rivals. In presence of an excess of copper salts (sulphate), bromides are totally decomposed in neutral solutions at the ordinary temperatures. The application of this method to test mixtures of chlorides and bromides gave satisfactory results.—Separation of nickel, cobalt, and iron, and of cobalt and aluminium, by M. E. Pinerua. Chloride of nickel is quite insoluble in ether saturated with hydrogen chloride, the chlorides of cobalt and iron, on the other hand, being easily soluble in this reagent. The method is sufficiently sensitive to detect the presence of nickel and iron in the "pure" cobalt chloride of commerce, and cobalt and iron in the nickel chloride sold as pure.—On cholesterine, by M. Ch. Cloëz.—On the grafting of *Helianthus annus* and *Helianthus lætiflorus*, by M. L. Daniel.—The proper motion of the sun, by M. Delauney.—On a new gas battery, serving as an accumulator, by M. C. Gaudet.

DIARY OF SOCIETIES.

THURSDAY, April 29.

Zoological Society, at 4.—Annual Meeting.
Chemical Society, at 8.—Monochlordiparaconic Acid and some Condensations: Dr. H. C. Myers.—On the Decomposition of Iron Pyrites: W. A. Caldecott.
Camera Club, at 8.15—The Automatic Telephone: S. B. Apostoloft.

FRIDAY, April 30.

Royal Institution, at 9.—Kathode Rays: Prof. J. J. Thomson, F.R.S.
Epidemiological Society, at 8.—Some Observations on the Infectivity of Diphtheria, and its Relation to School Closure: Dr. Louis Parkes.

SATURDAY, May 1.

Royal Institution, at 5.—Annual Meeting.
Geologists' Association.—Excursion to Cookham. Leave Paddington 1.40 p.m.; arrive Cookham 2.30 p.m. Director: Ll. Treacher.
London Geological Field Class.—Excursion to Leith Hill. Lower Greensand. Leave London Bridge, 2; arrive Holmwood, 3.17.

MONDAY, May 3.

Society of Arts, at 4.30.—Design in Lettering: Lewis Foreman Day.
Society of Chemical Industry, at 8.
Victoria Institute, at 4.30.—Nippur: its Inscriptions.
Camera Club, at 8.15.—Opening Address: Captain W. de W. Abney.—Photography at Sea: Captain Wilson Barker.

TUESDAY, May 4.

Royal Institution, at 3.—Volcanoes: Dr. Tempest Anderson.
Society of Arts, at 4.30.—The Arctic and Antarctic: Aubyn Trevor-Battye.
Zoological Society, at 8.30.—On the General Zoological Results of the Tanganyika Expedition of 1895–96: J. E. S. Moore.—On some European Slugs of the Genus *Arion*: Walter E. Collinge.—Field-Notes on the Antelopes of the Mau District, British East Africa: Frederick J. Jackson. With Notes by P. L. Sclater.
Royal Victoria Hall, at 8.30.—Mountains of Skye: Dr. T. K. Rose.
Gresham College (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

WEDNESDAY, May 5.

Society of Arts, at 8.—The Railway to India: C. E. D. Black.
Entomological Society, at 8.—Homœochromatic Groups of Butterflies: Mr. Blandford.
Society of Public Analysts, at 8.—The Value of the Nitrogen Factor in the Analysis of Decomposed Milks: Alfred Smetham and J. B. Ashworth.—Notes on the Influence of Boric Acid upon the Action of Digestive Ferments: R. A. Cripps.
Gresham College (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

THURSDAY, May 6.

Royal Institution, at 3.—Liquid Air as an Agent of Research: Prof. J. Dewar, F.R.S.
Society of Arts, at 4.30.—Kafistan: its Manners and Customs: Sir George Scott Robertson, K.C.S.I.
Linnean Society, at 8.
Chemical Society, at 8.—A Bunsen Burner for Acetylene: A. E. Munby.—On the Reactions between Lead and the Oxides of Sulphur: H. C. Jenkins and A. E. Smith.—Ballot for Election of Fellows.
Gresham College (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

FRIDAY, May 7.

Institution of Mechanical Engineers, at 7.30.—Experiments on Propeller Ventilating Fans, and on the Electric Motor driving them: William G. Walker.
Geologists' Association, at 8.—Coral Islands: W. W. Watts.
Gresham College (Basinghall Street), at 6.—Planets Saturn, Uranus, and Neptune: Rev. Edmund Ledger.

SATURDAY, May 8.

Royal Botanic Society, at 4.
Geologists' Association—Excursion to Southborough and Tunbridge Wells. Director: G. Abbott. Leave Charing Cross Station (S.E.R.) 9.22 a.m.; arrive Southborough 10.50 a.m.
London Geological Field Class.—Excursion to Caterham to Redhill, *viâ* Godstone. Upper Greensand. Leave Cannon Street 2.17; arrive Caterham 3.12.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Queen's College, Galway, Calendar for 1896–97 (Dublin, Ponsonby).—Royal University of Ireland, Exam. Papers, 1896 (Dublin, Ponsonby).—Les Transformateurs de Tension a Courants Alternatifs: F. Loppé (Paris, Gauthier-Villars).—A Treatise on Practical Plane and Solid Geometry: T. J. Evans and W. W. F. Pullen (Chapman).—Società Reale di Napoli. Atti della Reale Accademia delle Scienze Fisiche e Matematiche. Serie seconda, vol. viii. (Napoli).—Respiratory Proteids: Dr. A. B. Griffiths (L. Reeve).—Tea: a Text-book of Tea-planting and Manufacture: D. Crole (Lockwood).—The Materials of Construction: Prof. J. B. Johnson (New York, Wiley; London, Chapman).—Festschrift zum Siebenzigsten geburtstage von Carl Gegenbaur, Dritter Band (Leipzig, Engelmann).—Royal University of Ireland, Calendar 1897 (Dublin, Thom).—The Pamirs and the Source of the Oxus: G. N. Curzon (Royal Geographical Society).

Pamphlets.—Fünfter Jahres-Bericht des Sonnblick-Vereines für da Jahr 1896 (Wien).—The Street Railway System of Philadelphia: Prof. F. W. Speirs (Baltimore).

Serials.—Proceedings of the Physical Society, April (Taylor).—Journal of the Institution of Electrical Engineers, April (Spon).—Journal of the Chemical Society, March (Gurney).—Lloyd's Natural History. British Birds: Dr. R. B. Sharpe, Parts x. and xi. (Lloyd).—American Naturalist, April (Philadelphia).—Journal of the Franklin Institute, April (Philadelphia).—Terrestrial Magnetism, March (Cincinnati). Bulletin de la Société Impériale des Naturalistes de Moscou, 1896, No. 3 (Moscou).—Beiträge zur Geophysik, 3 Band, 2 Heft (Leipzig, Engelmann).—Journal of the Sanitary Institute, April (Stanford).—Zeitschrift für Physikalische Chemie, xxii. Band, 3 Heft (Leipzig, Engelmann).—Studien über Dampfspannkraftmessungen, 2 Abthg. 1 Hälfte (Basel, Schwabe).—Lean's Royal Navy List, April (Witherby).—English Illustrated Magazine, May (198 Strand).—Good Words, May (Isbister).—Sunday Magazine, May (Isbister).—Astrophysical Journal, April (Chicago).—Longman's Magazine, May (Longmans).—Quarterly Review, May (Murray).

CONTENTS.

PAGE