THURSDAY, MARCH 6, 1902.

THE VOYAGE OF THE "VALDIVIA."

Aus den Tiefen des Weltmeeres, Schilderungen von der deutschen Tiefsee-expedition. Von Carl Chun. (Jena: Gustav Fischer, 1900.) Lief. i.–xii. Price 18 mk.

ON the return of the German deep-sea expedition, it was decided to issue a popular account of the voyage and its results. Naturally this task fell to the leader, and in the volume before us Prof. Chun acquits himself of it.

The work opens with a short review of the history of deep-sea exploration, from the discovery by Sir John Ross in the year 1818 of living brittle-stars in 1000 fathoms of water to the outfitting of the German expedition in 1898—pages which will be read in this country with a justifiable pride indeed, but also with the conviction that exertion is needed if we are still to hold our own in scientific exploration. In enumerating the problems which yet remain to be solved, and for the discussion of which his expedition was to furnish material, Prof. Chun mentions the bionomics and embryology of deep-sea animals, the distribution equatorwards of polar organisms, and bipolarity, but he does not here refer to a question of considerable interest which has been greatly enlightened by the *Valdivia's* researches, the vertical distribution of the mesoplankton, which has been found, by the German expedition and by Dr. G. H. Fowler independently at almost the same time, practically to cease at about 1000 fathoms—a result which agrees neither with the view previously held in some quarters that pelagic life extended throughout the depth of the ocean, nor with the opposite opinion that it did not exist below two or three hundred fathoms.

The route of the cruise was determined by the decision to explore, as far as possible, portions of the ocean the deep-water fauna of which was as yet imperfectly known. Two of the most important of these being the South Atlantic and a great part of the Indian Ocean, the course decided upon was one which, passing through the Faroe Channel and thence southwards to the Canaries, followed roughly the western coast of Africa to the Cape, then struck south-west to Bouvet Island and south-east from Bouvet Island to the neighbourhood of Enderby Land, traversed the length of the Indian Ocean to the Nicobars, passing Kerguelen, New Amsterdam and Sumatra on the way, crossed from the Nicobars by Ceylon, the Maldives, the Chagos and the Seychelles to Dar-es-Salaam, and finally led back along the east coast of Africa, through the Red Sea and Suez Canal, to the Mediterranean and so home. Besides Prof. Chun, the expedition comprised ten scientific members, a photographer and a conservator. The vessel chosen was the *Valdivia*, a Hamburg to West Indies liner of 2176 tons register, and considerable alterations were made to fit her for the voyage, among others the fitting up of a large ice-room, which was found very useful in enabling deep-sea animals to be examined alive by being kept at a low temperature. The scientific equipment was very elaborate, and certain practical details are worth noting. Indiarubber accumulators, used to take the weight of the nets and their wire, were perished by the heat of the tropics, though fortunately others of steel spring were at hand. The "Blake" dredge proved less serviceable than a trawl, its iron frame cutting too deep into the ooze. The bucket of the vertical net was of glass and without filtering surfaces, whereby a smaller quantity of plankton was gotten, but in better condition. No doubt the quantitative net, built on Hensen's pattern, which was carried was provided with a porous bucket. Both Negretti and Zambra's upsetting thermometer and one of the Siemens electrical type proved useful, but the latter is said to need further improvements.

The history of the voyage is sketched in a series of chapters. These are written in a light and popular vein, and are beautifully illustrated by photographs of places and natives, but only a few points in them call for notice here. The important observations began when the Canaries had been passed. In the Guinea Stream, the low specific gravity of the water was found to be connected with a peculiarity of the plankton, the spines and other processes of which are longer than those of the forms found in the north and south equatorial streams. Dredging here gave poor results, but the deep-sea plankton is very rich. In lat. 25° 26′ S. was discovered, in 936 fathoms, a new bank, believed to form part of a ridge (the "Walfish ridge"), which parts the colder southern waters from the tropics, much as the Iceland ridge fends off the Arctic waters. The fauna of this bank is very rich. Careful dredgings were also made on the Agulhas bank, from which valuable results may be expected. There appears to be here an intermingling of Atlantic and Indian forms with typical Antarctic species, and Prof. Chun suggests that the latter are relics of a time when these waters were colder than at present.

One of the most important results of the expedition was the rediscovery of Bouvet Island in lat. 54° 26′ S. and long. 3° 24′ E. The *Valdivia* was only able to establish the existence of a single volcanic island some five miles by four, covered with an immense glacier, but the possibility is not excluded that a second may exist, corresponding to Norris's "Thompson Island." The search for this island in stormy weather amid mist and icebergs seems to have been a fine piece of work. Dredgings in the neighbourhood revealed a very rich fauna, intermediate between that of the Magellan region and that of Kerguelen, but with many new forms. Bouvet Island appears to be near the point of a tongue of cold water which extends northwards from the Antarctic region. On leaving it, the *Valdivia* coasted along the edge of the drift-ice which marks this tongue, in a south-easterly direction, till she was confronted with the edge of the pack-ice in the neighbourhood of Enderby Land. During the whole of this course, the water was of great depth, varying from 2000 to 3000 fathoms. The temperature curve was also very interesting. Owing to the presence of ice, the surface water is considerably cooler than that of intermediate depths, the actually coldest layer (about − 1°·5 C.) being at 30–40 fathoms. Below this the temperature rises, till at 300–400 fathoms it is 1°·7 C. Then it falls gradually and, at the bottom, is − ·5° C. Naturally, a number of icebergs were met with in this region, mostly of table form well known in the Antarctic and often of immense size. After a number of pages

devoted to an account of the origin and destruction of these bergs, Prof. Chun passes to a consideration of the Antarctic plankton. The *Valdivia's* researches were made at the height of the summer, when the surface fauna and flora were at their richest. In many respects they resemble those of the Arctic region, the most striking difference being the complete absence of Ceratium and the rarity of other dinoflagellates, the place of which was taken by immense numbers of diatoms, especially those of the genus Chætoceras. The greatest richness of the plankton was reached at 20–40 fathoms, the poverty of the surface waters being probably due to their lower specific gravity owing to the presence of melting ice. A twilight flora (Schattenflora), such as is found in the lower layers of the surface waters in tropical seas, is wanting in the Antarctic. On December 17, the ship was brought to a stand by the pack-ice some hundred miles north of Enderby Land in 2300 fathoms, and bore away north-west to Kerguelen. A dredging taken shortly after this showed a rather rich fauna and brought up a glacier-borne boulder of red sandstone, proving that Enderby Land is not of purely volcanic origin.

The voyage northwards across the Indian Ocean, which was saddened by the death of Dr. Bachmann, the physician and bacteriologist of the expedition, does not appear to have produced any very startling results. After leaving Padang in Sumatra, researches were made on the deep basin (some 1000 fathoms) between Sumatra and the Mentawi Islands. This basin is separated from the open ocean by a ridge of only 400 fathoms, on which the group is situated, and the bottom temperature is therefore higher (5°·9 C.) than that outside the islands. At the same time there is a very rich surface flora. Consequently the bottom fauna is extraordinarily rich. In this neighbourhood a specimen of Spirula was taken in perfect condition. A short visit to Suvadiva Atoll in the Maldives gives the author an opportunity for some remarks on that group. Since this visit, however, our formerly scanty knowledge of the Maldive Islands has been so vastly increased by Mr. Stanley Gardiner's expedition that the observations of the *Valdivia* are deprived of any value they might otherwise have had. Prof. Chun's ethnological conclusions are not very different from Mr. Gardiner's, but we very much doubt whether the latter author would accept the suggestion that the Maldives are built on a submarine mountain range. On the voyage to Diego Garcia, the very important discovery was made that the Chagos group and the Maldives are connected by a bank in 1100 to 1500 fathoms, this bank being sundered from that on which the Seychelles lie by a narrow channel only. The last section of the voyage in the Indian Ocean, that along the East African coast from Dar-es-Salaam northwards, in 500–700 fathoms, yielded the richest dredgings in the whole cruise.

At the end of the volume are some chapters on the deep-sea animals captured by the expedition and on general considerations concerning the oceanic fauna and flora. The "catch" was, on the whole, very much what might have been expected, and seems to contain many interesting forms, but few startling novelties. Hexactinellid sponges, actinozoa and echinoderms are naturally numerous, and giant forms of ostracoda, cirripedia and larvacea were taken. Deep-sea ctenophores were discovered, and some of the fish are perhaps even more bizarre than those that were already known from the deep sea. Naturally, the collections have not yet been sufficiently examined to enable general conclusions to be drawn from them with certainty, but Prof. Chun seems to incline to the view that the bottom faunas of the Arctic, Antarctic, Atlantic and Indian areas entitle them to be considered as distinct regions, in spite of the marked convergence between the members of the first pair and the identity of many species in the second. The surface fauna, and especially the surface flora, is much more peculiar in each region than the fauna of the bottom, but that of intermediate depths has a very uniform character in all, and, since many animals pass from the surface to lower layers of the water at fixed times of the year, it is possible to account for the cosmopolitan distribution of certain forms. On the subject of bipolarity, Prof. Chun is at present disinclined to pass an opinion.

To sum up in a few words the results of such an undertaking as the German deep-sea expedition is difficult. But it may, we think, be fairly said that not only have two or three discoveries of the first importance been made—such as the soundings in the neighbourhood of the Chagos group and off Walfish Bay, the "tailing off" of the pelagic fauna below 1000 fathoms, and the observations regarding Bouvet Island, but a mass of valuable information has been gathered which, when digested and discussed in the light of the facts accumulated by other expeditions, will set forward very notably our knowledge of the biology and physiography of the sea.

It is impossible to end a notice of this work without referring to the beautiful way in which it is brought out. The print, the margins, the numerous and artistic photographs, and the headpieces quaintly contrived out of representations of sea animals are all beyond praise and can only be made possible in a work issued at the price of the present one by a wide popular appreciation in Germany of the results of the expedition. What sort of public would such a work find in English?

L. A. B.

CHEMICAL ANALYSIS.

Practical Chemistry. By Abegg and Herz. Translated by H. T. Calvert, B.Sc. Pp. xiii+118. (London: Macmillan and Co., Ltd.) Price 6*s*.

THIS little work, which deals mainly with qualitative analysis, is based upon the principles of modern physical chemistry. The equations representing "reactions in solution" are written in the ionic form, thus:—

$$Mn'' + 2OH' = \mathbf{Mn(OH)_2}$$
$$Fe''' + PO_4''' = \mathbf{FePO_4}.$$

This method of representing reactions in solution as being entirely dependent upon the "ions" has its advantages, but it also has certain disadvantages. In most text-books the above equations would be represented by the action of definite salts, as, *e.g.*,

$$MnSO_4 + 2KOH = Mn(OH)_2 + K_2SO_4$$
$$FeCl_3 + Na_2HPO_4 = FePO_4 + HCl + 2NaCl.$$

When expressed in the latter form, students are apt to

suppose that the reaction only takes place when the special salt mentioned in the book is used, and if any other salt of the metal is offered to them to say, "but the book says such and such a salt is to be used." On the other hand, when the equations are expressed in the ionic form, as above, the student is perhaps inclined to forget that the anion of the metal and the cation of the reagent also interact.

There are those who look upon the "ionisation theory" as absolutely false and will have none of it. Others, mistaking theory for fact, ridicule all other theories and dogmatically state that *all* difficulties are surmounted when approached by means of the ionic theory. There are many, however, who, without subscribing to the opinions of the extremists, recognise in the ionic theory an extremely useful working hypothesis. Chemical analysis, which is apt to be dry and dull when viewed in —dare we say—the old-fashioned manner, becomes not only interesting, but many of the reactions which were obscure become clear in the light of the ionic theory. Thus, is the action of caustic alkalis upon ferric ferrocyanide (Prussian blue) always clear to students of the old regime? They are told that caustic alkalis decompose the compound according to the following equation :—

$$Fe_7(CN)_{18} + 12KOH = 4Fe(OH)_3 + 3K_4Fe(CN)_6 ;$$

but this does not explain why the whole of the iron is not precipitated as ferric hydrate. Now according to the ionic theory, this would be explained by saying that Prussian blue is dissociated into the cations $4Fe^{\cdots}$ and the complex anions $3Fe(CN)_6^{\prime\prime\prime\prime}$ and that only the iron present as the cation is acted upon by the OH' of the potassium hydrate.

The arrangement of the book before us is in some respects peculiar. The student is first instructed how to construct a wash-bottle. This is followed on p. 3 by the preparation of hydrogen. The preparation of oxygen comes after that of hydrochloric acid and sulphuretted hydrogen, and is followed in succession by the methods of preparation of chlorine, sulphur dioxide, carbon dioxide and ammonia.

The analytical portion covers the usual ground and contains the usual reactions. Some portions of the chapter on "theoretical foundations" are far from clear, and we very much question whether the average reader will readily understand the two and a half pages on hydrolysis.

In a pocket at the end of the book there is a rather ingenious blank draught-board with the cations arranged along the top and the anions down the side. The compounds formed by the various ions are to be indicated in their proper squares, and if they are precipitates they may be indicated by shading or by filling in with coloured chalks.

The book has a table of contents, but no index. Even if the German edition was not indexed, surely the translator might have supplied one.

By the way, would it not be well if English writers of chemistry books would arrange always to write the positively charged ion in the same way? As it is, we find it sometimes spelt cation and sometimes kation.

F. M. P.

THE MOVEMENTS OF THE FOOT AND WRIST.

Der Gang des Menschen. iv. Thiel. *Ueber die Bewegung des Fusses und die auf denselben einwirkenden Kräfte.* Von Otto Fischer. Pp. 86 ; 3 plates. (Leipzig : Teubner, 1901.) Price Mk. 5·50.

Ueber die Bewegungen in den Handgelenken. Von Rudolf Fick. Pp. 54 ; with 8 figures in text and 10 plates. (Leipzig : Teubner, 1901.) Price Mk. 6·50.

IT is strange that two men, working side by side within the same university, publishing results of investigations on similar subjects in consecutive pages of the *Proceedings* of the same learned society, should produce two treatises so diverse in nature as those of Dr. Otto Fischer and Prof. Fick. Each employs a peculiar and comparatively new method for the solution of problems which have been thumbmarked by ten generations of anatomists. Dr. Fischer is a mathematician as well as an anatomist, a combination so rare that, in applying the later methods of mathematical physics to the elucidation of the movements of the human body in walking, he has left his colleagues far behind and is almost without audience or critic. Prof. Fick's paper is the result of the application of Röntgen rays to the study of the complex movements of the wrist-joint, a method only comparatively new.

If these authors differ in the methods they have employed they are alike in this, that they are minute, painstaking and accurate, investigating fully every fact for its own sake, with no thought whatsoever as to its utility. Prof. Fick has determined in millimetres the extent and direction of the movements undergone by each of the nine carpal bones during flexion, extension, abduction and adduction of the wrist. In the last paragraph of his paper he sums up his main result as follows :—

"In conclusion I would once more emphasise, what this research has again demonstrated, that the mid-carpal joint is indeed no paltry minor articulation (Kein unwichtiges Nebengelenk) deserving the stepmotherly consideration (stiefmütterliche Berucksichtung) extended to it by most practitioners, but that, for many movements of the hand, it is emphatically the chief joint."

In this conclusion the author, as he himself explicitly states, only verifies the observation made many years ago by Henke. The elaborate and expensive plates, the type and style in which Prof. Fick's work has been published, make an English anatomist envy the wealth of a German society that is able to devote so much of its funds to the elucidation of so small a part of the human body.

In his last contribution to the Kinematics of the human gait, Dr. Fischer dealt with the movements of the lower extremity during the cycle of a double stride ; in this, his fourth contribution, he considers the movements of the foot during a corresponding period. The foot is dealt with as if it were detached from and independent of the rest of the body. The forces which act on it during the cycle of a double stride are traced to four sources, viz. the muscles (extensor and flexors of the foot), weight of the body, weight of the foot and reaction of the ground. The points at which these forces are applied and the centre of gravity of the foot are determined and diagrammatically represented. The velocity and acceleration of the

centre of gravity of the foot, in the forward, lateral and vertical directions, during the period of a double stride, are determined and diagrammatically represented in three very carefully prepared plates. A. K.

OUR BOOK SHELF.

Ueber angewandte Mathematik und Physik in ihrer Bedeutung für den Unterricht an den höheren Schulen. Nebst Erlauterung der bezüglichen Göttinger Universitätseinrichtungen. Vorträge . . . gesammelt von F. Klein und E. Riecke. Pp. viii + 252. (Leipzig: Teubner, 1900.)

THIS miscellaneous collection falls into two parts. The first consists of eight lectures delivered to teachers in higher schools during a vacation course at Göttingen; of these the first is a sketch of the history of the Physical Institute at Göttingen and the instruction given there; the others deal with various technical branches of applied science in which mathematics plays an important part. The second and probably, to the English reader, the more interesting part of the volume is a reprint of various essays and addresses by Prof. F. Klein, in which he discusses the relation of universities to technical high schools (technische Hochschule). Prof. Klein is clearly of opinion that in Germany these two classes of institutions have become unduly isolated from each other, and should aim at greater solidarity, working loyally for their common welfare.

As one who is interested in the work of both, as well as in the good of the State, he deprecates the tendency in the universities, on the one hand, to divorce the study of mathematics from its practical applications, and in the technical schools, on the other, to take too narrow a view of mathematical science and regard it *merely* as subsidiary and subordinate to the requirements of practical engineering and the like. These tendencies are not wholly unknown in England, and Prof. Klein's arguments and suggestions deserve the attention of our mathematicians and teachers of applied science both in the universities and elsewhere. M.

The Ethical Philosophy of Sidgwick. By F. H. Hayward. Pp. xxiv + 275. (London: Swan Sonnenschein and Co., Ltd., 1901.) Price 4*s.* 6*d.*

A MOST useful though modest and unpretentious little work. In the nine essays of which it is composed the author summarises the main features of the doctrine of the "Methods of Ethics," and discusses from the point of view of an admiring but candid and discriminating reader the principal difficulties of Sidgwick's position. On the vexed question whether Sidgwick is in his ethics fundamentally an egoist or not, Mr. Hayward decides, after a careful examination, in the affirmative, with good reason as the writer of this notice thinks. A good feature of the book is the very full and impartial statement of the controversial arguments against Sidgwick urged by evolutionists on the one side, and neo-Kantians on the other. The care with which the changes in the successive editions of the "Methods" have been noted and allowed for and the thoughtful provision in the opening pages of a summary of Sidgwick's often prolix argument add to the value of a book which all students of ethics will find useful and suggestive. If the book should reach a second edition perhaps the author will tell us more definitely how far he regards the presence of apparently conflicting points of view in the "Methods" as due to excessive care in formulating a delicately balanced and consistent theory, and how far to the attempt to unite together elements which are really irreconcilable. At present he seems to hesitate in his verdict. As a scholar it is to be trusted he will purge future editions of such misspellings as "Königsburg" and *ἐνεργεία*, and such ugly formations as "perfectionistic" and "introspectionist." A. E. T.

On Traces of an Indefinite Article in Assyrian. By R. Campbell Thompson, M.A. Pp. 31. (London: David Nutt, 1902.) Price 2*s.* 6*d.*

IN this interesting pamphlet the author has attempted to throw some light upon an obscure point of Assyrian grammar, which for some years past has engaged the attention of Semitic scholars, although no completely satisfactory explanation has hitherto been given of it. The point to be explained, and to which attention was first called by Dr. Flemming, is the occasional occurrence of Assyrian and Babylonian words in which the case-endings have been dropped, although the words in question are not in the construct state. The explanation which is now generally accepted, and which was first put forward by Prof. Jensen, assumes that the dropping of the case-endings was a result of the degeneration of the language, a process which finds a parallel in modern Arabic. Mr. Thompson, however, suggests that we may see in the omission of the case-endings traces of an absolute state in Assyrian, similar to that in use in Aramaic; and, assuming this to be the case, it follows that the noun with the case-endings possesses the force of the emphatic state in Aramaic, although it appears to have no equivalent for the post-positive article. Mr. Thompson has arranged his examples to illustrate the rules which hold good for the absolute in Syriac; but he does not run his theory to death, and is fully conscious that the occurrence of variants with the case-endings shows that "the noun need not of necessity adhere to any fixed law."

We cannot here go into detailed criticism of the examples cited, but will only refer to one fact which appears to us to favour the received explanation rather than that here put forward. According to Mr. Thompson, the omission of the case-endings is due to *survival*, and not to degeneration. We should expect, therefore, to find the examples of its occurrence commoner in the early texts than in those of the later periods; as a matter of fact, the reverse appears to be the case. In the Old-Babylonian inscriptions, the case-endings (apart from the use of the construct) are rarely omitted, while the most striking examples of their omission occur in Assyrian and Neo-Babylonian texts. We must congratulate Mr. Thompson on the clearness and brevity with which he has stated his case, and Assyriologists will find the collection of extracts he gives most useful for a study of the question.

Sir Thomas Browne's Notes and Letters on the Natural History of Norfolk. Edited by T. Southwell. Pp. xxvi + 102. (London: Jarrold and Sons, 1902.)

NORFOLK sportsmen and naturalists—and they are many—will be sure to find much to interest them in a work dealing with the fauna of their county as it was in the middle of the seventeenth century, when, as the author tells us, cranes were often seen in hard winters, while bustards were comparatively abundant, although never, perhaps, so common as is often supposed. Sir Thomas Browne, it appears, was a Norwich physician who in early life travelled much. Although not to be compared in point of interest with those of Gilbert White, his letters and notes indicate a keen and shrewd observer of natural history. A large part of the value of the work is, however, due to the editor, who is well known for the keen interest he takes in all that concerns the natural history of the county. Not only has he deciphered with rare skill and patience a vast amount of crabbed MS., but he has contributed a series of foot-notes containing much valuable and interesting information. R. L.

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.*]

Botany by Indian Foresters.

A GLANCE at the *Indian Forester* for February affords a complete refutation of recent charges brought against the Indian Forest Department for neglect of botany.

This number commences with a most able and interesting account of the forests of the Sudan, written by Mr. Muriel, of the Indian Forest Department, who was sent last year to examine the forests along the Blue and White Niles and the Bahr-el-Ghazel. After travelling for 4600 miles, Mr. Muriel wrote a description of the chief components of the Sudanese woodlands and savannahs, and especially of the cultivation of *Acacia verek*, the Sudanese gum tree, from which last year 80,000 cwt. of gum, valued at 80,000*l*., was delivered at Khartum.

Ordinary timber is valued at 2*s*. a cubic foot at Khartum, while large quantities of wood fuel are required for steamers on the Nile and for locomotives, as well as for culinary purposes, so that the importance of the protection of the forests against incendiary fires and unrestricted grazing and felling is evident. Mr. Muriel has given a very interesting account of the fauna of these regions as well as of their flora, and it is satisfactory to learn that the very able forester and botanist, Mr. A. F. Broun, who has recently assisted Sir D. Brandis at Kew in his new book on the Indian forest flora, has been appointed Conservator of Forests in the Sudan.

In the same number of the *Indian Forester* is a paper by Mr. A. W. Lushington, of the Indian Forest Service, on the identification of seventy-four Indian species of Loranthaceæ by means of their ramification and leaves. He states that it is not uncommon in southern India to find forests completely ruined by these parasites. "The vegetation, weakened by forest fires, is incapable of battling with these pests, and as the better species of timber trees are less well supplied with sap than the inferior species, the former are the first to be killed." As the Loranthaceæ are classified by their flowers and the latter exist only for a short period, while the forest officer has a very large district to supervise and may not meet with some of the species in flower, the utility of Mr. Lushington's work is apparent.

Babu Upendranath Kanjilal, of the Indian Forest Department, has just published a most excellent and handy volume on the local forest flora of the School Circle, North-West Provinces of India, where the forests range in altitude from 1000 to 10,000 feet above sea-level. This work is also referred to in the February number of the *Indian Forester*, in which is also found a list, systematically arranged, of trees and shrubs in the Jerruck division of Sind, by Mr. G. K. Betham, of the Indian Forest Department.

Any habitual reader of the *Indian Forester* will see that Indian forest officers pay considerable attention to biology, chiefly as regards plants and insects; but, after all, their chief duty is the economic management of the Indian forests, and the great amount of work this involves and its value to the Indian Empire can be appreciated only by those who have given a fair attention to forestry in all its bearings.

Besides British India and the included and adjoining native States, such as Cashmere, Indian foresters are now employed in Siam, the Philippine Islands, Cape Colony and the Sudan. Owing to the great devastation of woodlands in the Transvaal and Orange River Colonies, which is graphically described in a recent number of the *Revue des Eaux et Forêts* (the *French Forestry Magazine*), it is to be hoped that a sound administration of forestry may soon be established in these territories.

Coopers Hill, February 24. W. R. FISHER.

Cherry Disease.

MY attention has just been called to a letter in your issue of January 30 from Sir W. T. Thiselton-Dyer, which gives the strongest possible confirmation to my contention that a fully equipped State Agricultural Laboratory is a national desideratum, and that in this respect Britain is behind other countries.

Your correspondent implies in his letter that with Kew and the British Museum in existence there is no pressing need for any other institution. The Director's letter proceeds to relate what Kew has done "promptly and in ordinary routine" for the protection of the British farmer against the cherry disease; and the sum of it is that in November, 1900, Kew answered an inquiry from Mr. A. O. Walker by telling him that the fungus on the cherry leaves sent by him was *Gnomonia erythrostoma*. The next step taken by Kew—and the only public one—is the director's ungenerous criticism of what has been done meanwhile by the Royal Agricultural Society. (Mr. Walker's letter to the *Gardeners' Chronicle* in May, 1900, was apparently his own private action, in no way initiated by Kew, and was certainly not an official step.)

A pathogenic fungus can be named at any time in ordinary routine for an individual inquirer either at Kew or at the British Museum; but this is the smallest part of the work of a State Agricultural Laboratory.

The Royal Agricultural Society of England, which—public-spirited though it be—is not a State-supported institution, took some practical steps. It was not until December 1900 that a specimen of the cherry disease was received at the laboratory of that Society, and at the next council meeting on February 5, 1901, I reported on the disease. This report was published in the agricultural papers of that and the following weeks, and was widely distributed in leaflet form by the Society among the Kent cherry-growers, to its own members and to non-members indiscriminately. A conference with the cherry-growers at Maidstone followed, and the result has been that the disease was carefully observed, and sufficient information reached the Society's laboratory to enable the publication in its *Journal* of a detailed account of the disease as it has appeared in England. I regret to add that I have received specimens of wild cherry from Somerset attacked by the Gnomonia.

Any benefit which may conceivably have come to the British farmer from Kew in this matter accrued indirectly in May through the action of a private individual. The Royal Agricultural Society had already in February taken the valuable practical steps which in most other countries would have been the duty of a State Agricultural Laboratory.

I need not trouble you in regard to your correspondent's kind correction of an intentionally indefinite description in my report, which has been put right in its final form, issued ten days before his letter was published; nor with his other criticisms upon your report of the meeting of the Royal Microscopical Society, criticisms which to an intelligent and careful reader answer themselves. WILLIAM CARRUTHERS.

44 Central Hill, Norwood, February 22.

MR. CARRUTHERS' letter is open to some criticism. Taking it, however, as it stands, it proves conclusively that in the case of the cherry-leaf disease everything has been done by existing agencies that was practically possible. This particular instance therefore affords no basis for the demand for a State Agricultural Laboratory.

As I have already stated, the disease does not appear to have been brought under the notice of the Board of Agriculture. Had it been so, that department, if it had seemed desirable, could have relieved the Royal Agricultural Society of the task of preparing and distributing a leaflet. Mr. Walker, however, points out in NATURE for February 6 (p. 318) that "the disease has almost disappeared, though no preventive measures such as stripping the leaves were taken."

The object of my letter was to make a protest against the present tendency to demand fresh State machinery instead of endeavouring to increase the usefulness of that which already exists. W. T. THISELTON-DYER.

Kew, February 26.

Identity of Negative Ions Produced in Various Ways.

FROM the results of some experiments which I have recently made, it can be shown that the negative ions produced in various gases by Röntgen rays, or by collision, are all identically the same and are smaller than the molecules of hydrogen.

The following results have been established by the researches on this subject which have been already published (J. S. Townsend, *Phil. Mag.*, February 1901; J. S. Townsend and P. J. Kirkby, *Phil. Mag.*, June 1901; P. J. Kirkby, *Phil. Mag.*, February 1902):—

(*a*) The negative ions produced in a gas by Röntgen rays

generate other ions by collisions with the molecules of the gas when they move sufficiently rapidly.

(*b*) For any gas the negative ions which are generated by collisions are the same (having the same properties over wide ranges of force and pressure) as those which were generated by the rays.

(*c*) If α is the number of negative ions generated in a gas by one of these negative ions moving through one centimetre, then $\alpha = pf\left(\frac{X}{p}\right)$, where p is the pressure of the gas and X the electric force acting on the ion.

(*d*) The free paths of the negative ions are long, compared with the free paths of the molecules, so that their linear dimensions must be smaller than those of the molecules.

From a comparison of the properties of positive and negative ions, it can be seen that the mass of the negative ion must be small compared with that of the positive ion.

The values of α were determined for large ranges of pressure and electric force for air, carbonic acid and hydrogen, and the functions f have been represented graphically by three curves. Let f_1, f_2 and f_3 denote the functions f found for air, carbonic acid and hydrogen respectively as determined by the experiments with Röntgen rays.

The results which I have to add to these were obtained by finding the conductivities of gases between parallel plates when one of the plates is illuminated by ultra-violet light.

The experiments have led to the following conclusions :—

(*a'*) The negative ions set free from a zinc plate when ultra-violet light falls on it generate other ions by collisions with molecules of air, carbonic acid or hydrogen.

(*b'*) The negative ions thus generated by collision in the gases have the same properties (over large ranges of pressure and electric force) as the ions generated by the light from the zinc.

[Hence these four kinds of ions are identical, viz., the ions given off from the zinc plate and the negative ions which they produce in air, carbonic acid or hydrogen. These negative ions may be denoted by the letter Z.]

(*c'*) If α' is the number of ions which one of the Z ions produces per centimetre by collisions with molecules, then α' is connected with the electric force and the pressure by an equation of the form $\alpha' = pf'\left(\frac{X}{p}\right)$. The three functions f_1', f_2', f_3' as determined in this manner for air, carbonic acid and hydrogen are equal respectively to the corresponding functions f_1, f_2, f_3 as determined by the experiments with Röntgen rays. The equality extends over the whole ranges of pressures and force which have been examined.

Consequently the negative ions generated by Röntgen rays in a gas are precisely the same as the ions set free from a zinc plate by ultra-violet light.

If it be questioned that the identities $f_1 \equiv f_1'$; $f_2 \equiv f_2'$; $f_3 \equiv f_3'$ are sufficient to justify this conclusion we may proceed to establish the proposition in the following manner :—

The charges on negative ions produced by Röntgen rays in any of the gases under consideration have been shown to be equal to the charge on a negative ion given off from a zinc plate by ultra-violet light (J. S. Townsend, *Phil. Trans.* 1899 and 1900).

For simplicity, one of the gases may be considered, air, for example. Let m be the mass and e the charge on a negative ion R produced in air by Röntgen rays, and let m' and e' be similar quantities for an ion Z produced by the aid of ultra-violet light.

Since the maximum values of f_1 and f_1' as determined by the larger values of $\frac{X}{p}$ are equal the two kinds of ions R and Z must produce the same number of collisions per centimetre so that they have the same free paths. For any force X, the kinetic energy that the R and Z ions acquire along their free paths must be equal since their charges are equal. At the end of a path of length x the value of $\frac{mv^2}{2}$ or $\frac{mv'^2}{2}$ is equal to Xex.

Hence we have the equation $mv^2 = m'v'^2$, v and v' being the velocities of the ions R and Z before collision.

A second independent equation is obtained when we consider the identity $f_1 \equiv f_1'$.

The chance of producing new ions by collision is not determined by the energy of the colliding ion. If this were the case, the positive ions would produce others by collision under an electric force X if their mean paths became equal to the mean paths of the negative ions when they generate other under the action of the force X. It is easy to show that the positive ions do not acquire the property of producing others by collision even when their free paths are much longer than those of the negative ions when they are giving others by collisions. The negative ions therefore possess this ionising property in virtue of the large velocities they acquire along their free paths. It is therefore evident that the function f involves the mass and velocity of the colliding ion in some form which is not reducible to the product $m \times v^2$. The equality of f_1 and f_1' for the same values of e, X and p supplies us with an equation between m, v, m', v', of the form $\phi(m, v) = \phi(m', v')$. Combining this equation with the equation $mv^2 = m'v'^2$, we see that $m = m'$ and $v = v'$.

Hence the masses of the two ions R and Z are the same as well as their free paths and charges. We thus see that it is possible, by various methods, to detach negatively charged particles from the molecules of gases which are small compared with the molecules, and that the particles which are detached are the same from whatever gas they are removed.

JOHN S. TOWNSEND.

New College, Oxford, February 28.

The Recent Fall of Red Dust.

SOME observations made last autumn in Cornwall may throw light on the fall of dust in South Wales. On September 2, during gusty weather with squalls from the E.N.E., I watched from my window at Carbis Bay (270 feet above the sea) puffs and swirls of dust rising from the desert-like flat at the mouth of the Red River. The dust-cloud rose above the top of Godrevy Towans (230 feet), nearly blotted out Godrevy Lighthouse and then spread in a well-defined belt across St. Ives Bay for more than three miles to near St. Ives Head, which it must have passed, though this part of the track was invisible from my point of view. A fortnight earlier a similar observation had been made under identical conditions by Mrs. Reid. On neither occasion did the wind reach the force of a gale, it was merely a strong, dry east wind.

The red mud which gives its name to the Red River is mainly slime produced by the crushing of the tin-ore in the stream-tin works. This mud spreads far and wide over the alluvial flats and along the sandy shore; when it dries it forms an almost impalpable dust. Much of this dust is mixed with the Cornish sand-dunes, and drifts to and fro with the shelly sand, which forms the main part of those dunes. If the dust-falls in South Wales are of Cornish origin, the material will probably contain a good deal of finely powdered schorl, which mineral occurs abundantly in the tin-ore. CLEMENT REID.

The Validity of the Ionisation Theory.

THE number of NATURE which appeared on January 30 contains an abstract of a paper by L. Kahlenberg entitled "The Theory of Electrolytic Dissociation as viewed in the Light of Facts recently Ascertained." In the paper referred to is a kind of summary of observations which have been made on non-aqueous solutions, from the consideration of which the author draws the conclusion that the electrolytic dissociation theory is untenable in the case of non-aqueous solutions.

In view, however, of the generally accepted opinion that this theory is in good accordance with experimental observations on aqueous solutions, Kahlenberg has been led to investigate such solutions more closely. As the result of a large number of boiling-point, freezing-point and conductivity determinations, the conclusion is drawn that "the difficulties which the theory of electrolytic dissociation encounters in explaining the phenomena in aqueous solutions are really insurmountable."

One of the chief reasons for this inference appears to be that the series of molecular weight values calculated from the cryoscopic and ebullioscopic measurements at different concentrations of the solutions are irregular. As an example, it is found that in the case of solutions of magnesium sulphate, the calculated molecular weight, which even in the most dilute solution is greater than the theoretical value, increases at first with the concentration, passes through a maximum and then decreases, attaining a value which would correspond to electrolytic dissociation only in the most concentrated solutions. The author does not state in what manner these "molecular

weights" have been calculated, but presumably the ordinary formula has been employed. It is important to note that in seven out of the nine boiling-point measurements carried out with magnesium sulphate, the concentration of the solution varies from about 15 per cent. to over 40 per cent. In other experiments with solutions of cane sugar, concentrations varying from 20 grams to 290 grams of sugar per 100 grams of water have been employed, the calculated "molecular weight" (theory = 342) decreasing from 360 to 212 at the highest concentration.

To attribute to the numbers calculated by means of the simple boiling-point formula for solutions of such concentrations the significance of molecular weight values can scarcely be regarded as justifiable. In so far as the ordinary freezing-point and boiling-point formulæ rest on a thermodynamical basis, they only hold good for ideal solutions; for such solutions the formulæ in question will give molecular weight values, but it has yet to be shown that the numbers calculated by Kahlenberg from his experiments can be taken as representing molecular weights.

For moderately concentrated solutions which no longer satisfy the requisites of an ideal solution, distinguished by the properties that no heat is evolved or absorbed and no change of volume takes place when it is diluted, Ewan, amongst others, has deduced an expression connecting the osmotic pressure with the lowering of the freezing point, the formula resting on a thermodynamical basis. This formula, when used for the calculation of molecular weights, gives, even with solutions containing as much as 40 per cent. of cane sugar, values scarcely differing from theory (342), whereas the simple freezing-point formula for a solution of the concentration mentioned gives 275.

Another reason advanced by Kahlenberg to prove the inadmissibility of the ionic theory is the lack of agreement between the numbers representing the degree of dissociation as calculated from the conductivity on the one hand and the freezing- or boiling point on the other. If for the reasons previously stated the calculations based on the boiling-point and freezing-point measurements have little significance so far as the ionic theory is concerned, it is obviously impossible to effect the required comparison. Furthermore, it seems questionable whether the numbers calculated by the formula $\alpha = \frac{\mu_v}{\mu_\infty}$ really represent degrees of dissociation. The formula involves the as yet unproved and scarcely probable assumption that the ionic velocities are the same in solutions of all possible concentrations. The development of the ionic theory is by no means conditioned by the validity of such a formula. So far as Kahlenberg's measurements are concerned, the comparison between the results of the boiling point and conductivity measurements is moreover, impossible, except in the case of the binary salts, since the range of concentrations employed is quite different.

Although, therefore, the publication contains a large number of valuable empirical data, yet it cannot be allowed for one moment that the ionic theory has been shown to be untenable. It is far from the wish of the writer to minimise the difficulties which do admittedly confront the theory of electrolytic dissociation. It must not, however, be supposed that the theory has received its final and complete form; the possibilities of its rational expansion and development to explain existing irregularities are far from being exhausted. A warning note may be sounded against a too ready assumption that new experimental data prove the untenability of the theory without very careful consideration of what exactly is, and is not, stipulated by the theory.

H. M. DAWSON.

The Yorkshire College, Leeds.

Birds attacking Butterflies and Moths.

I WAS much interested in the letter in NATURE of January 16 on the frequent capture of butterflies in India by the King Crow, as some years ago I experimented with a captive bird of this species, and found that it avoided "warningly-coloured" butterflies when possible, and was deceived by mimicry (*J. A. S. B.*, ii. 1897, p. 651).

With regard to the capture of butterflies by bush-haunting birds which do not take them on the wing, I pointed out as long ago as 1895 (*J. A. S. B.*, ii. 344) that the common Babbler *Crateropus canorus* was likely to meet with butterflies in repose, and proved experimentally that it dislikes the "warningly-coloured" species. But I could then give no positive evidence that it does, as a matter of fact, attack butterflies on its own account, though it will take them if thrown in its way.

I therefore give here the results of a few experiments which, in my opinion, show that this bird also naturally preys on butterflies.

In March last year I gave to a wild-caught bird of this species a *Danais limniace* together with a Junonia. The bird took and ate the latter; I then removed the Danais.

I have just now been offering three specimens of *Danais genutia*, together with three plain brown butterflies, to three wild-caught adult Babblers placed in separate cages.

Two of the birds disregarded the Danaids until they had eaten the other butterflies, and then did not attack them eagerly or eat them (except the abdomen in one case), although they had no food in their cages at the time.

I conclude, therefore, that they were last year's birds, which knew and disliked *D. limniace*, and the present two *D. genutia*, from previous experience in catching and tasting butterflies when wild.

The third bird experimented with to-day attacked its specimen of *D. genutia* first, but soon left it to eat the other butterfly given; nor did it tear the Danais to pieces as did the others, although, like them, it had no other food in its cage.

Either, then, this bird had forgotten its wild experience, or, what is more likely, it had never happened to catch *D. genutia*, and so knew nothing about this species, which it evidently disliked, from what has been said above, although it was not impressed by the "warning colours."

In my previous experiments with this Babbler I did not observe the same precautions, when *first* offering the butterflies to the birds, as I did in these later experiments, so that the results I obtained, although sufficiently demonstrative of the preferences of the species, threw no light on the individual experience of the specimens experimented with.

F. FINN.

Indian Museum, Calcutta, February 6.

SI cela peut intéresser vos lecteurs: . . . dans une traversée de la Mer des Caraïbes sur le steam. angl. *Mariner*, en Mai, 1886, nous fûmes, par un temps calme, assaillis par un grand nombre de tout petits oiseaux, bien qu'à une assez grande distance de la terre, invisible. Ils poursuivaient de petits papillons qu'ils venaient happer au vol jusques sur mes genoux. J'étais assis très fatigué et un peu inerte sur la dunette. Je ne pouvais songer à déterminer oiseaux ni insectes. Les matelots laissaient faire. La brise fraîchit et tout ce petit monde disparut en un clin d'œil. Que sont-ils devenus?

AD. NICOLAS.

Angers (M.-et-L.), le 22 Février.

On Prof. Arrhenius' Theory of Cometary Tails and Auroræ.

IN the more or less popular accounts which have recently been given of Prof. Arrhenius' theory of cometary tails and the auroræ, it is generally stated that the smaller the diameter of the corpuscle upon which the light is falling the greater the excess of light-pressure over gravitational force. This explanation, however, holds only so long as the diameter is greater than the wave-length of light. If the diameter becomes of the same order as the wave-length, the ratio between light-pressure and gravitation follows an entirely different law. This has recently been demonstrated by Prof. Schwarzschild by an exhaustive mathematical treatment of the question in a paper entitled "Der Druck des Lichtes auf kleine Kugeln und die Arrhenius'sche Theorie der Cometenschweife" (*Sitzungsberichte* der k. b. Academie der Wissenschaften zu München, 1901, Heft iii.). The conclusions arrived at in this paper are of considerable importance in so far as they show that the effect of gravitation is exceeded by that of the pressure of light only so long as the diameter of the corpuscle is greater than about $0{\cdot}07\mu$. For this limiting value the two forces are exactly balanced; but for smaller values of the diameter the light-pressure becomes rapidly less, so that it is then always exceeded by gravitation. It would appear from Prof. Schwarzschild's computations that the globular corpuscles thrown off in the tails of comets should have diameters not smaller than $0{\cdot}07\mu$ and not exceeding $1{\cdot}5\mu$, supposing the specific gravity of the corpuscle to be that of water. Now these values far exceed the limits assigned to the dimensions of the molecules. According to our present knowledge, based on

theory as well as on experiment, we are forced to conclude that the diameter of a molecule cannot be larger than 0·003μ. On the other hand, the specific gravity of a molecule of air, for instance, appears to be very great, viz. five times that of water (see Meyer, "Die kinetische Theorie der Gase"). This maximum value of the diameter of a molecule is so enormously smaller than the values demanded by Prof. Arrhenius' theory that the latter appears to be incompatible with any assumption which regards the cometary matter as being of a gaseous constituency. In order to explain the repulsion of matter in the tails of comets by the pressure of the sunlight, this matter must be assumed to consist of small drops, each of a bulk sufficiently large to harbour at least one million molecules within its bounding surface. Whether such an assumption can be justified appears to me very doubtful. At any rate, Prof. Schwarzschild's profound mathematical investigation makes it absolutely clear that the idea of minute electrically-charged corpuscles—of about one-thousandth the size of a hydrogen atom (see *Observatory*, February 1902, p. 103)—being propelled by the sun's light towards the earth and causing the various phenomena of auroræ, Gegenschein, &c., receives no support from the mathematical point of view. But, even apart from these difficulties, it can hardly be said that the ingenious theory of Arrhenius settles the question as to the nature of the force acting on the cometary matter. So far it offers no explanation of the remarkable phenomenon of the contraction of the coma with the approach towards the sun. Doubtless this *contractile* force is also of solar origin. But can it be identified with the force which repels the cometary matter in the direction of the radius vector? It appears to me that the theory in its present form only removes one difficulty by introducing several others. J. HALM.

Royal Observatory, Edinburgh, February, 20.

Experimental Geometry in Secondary Schools.

IN the report, in your issue of February 27 (p. 404), of a meeting of the Mathematical Association, it is stated to have been the opinion of most speakers that the study of demonstrative geometry should be preceded by a course of work with ruler, compasses and protractor, in which simple measurements and constructions form the chief part. The note continues with the statement that such a course has been adopted in Scottish schools, and in English elementary schools and kindergartens.

May I venture to point out that there are a considerable number of secondary schools where this kind of work forms a regular part of the curriculum in the lower mathematical classes (this has, for instance, been the case here for the past three years), and that it has been recognised as a valuable medium by which a boy's interest may be aroused in geometry before he is introduced to the very irksome and difficult task of assimilating Euclid's phraseology? C. A. RUMSEY.

Dulwich College, March 5.

The Zodiacal Light.

THE zodiacal light was visible here last night at 7h. 30m. p.m. The base at the horizon was about 16° wide; the axis of the cone pointed towards the Pleiades, but the apex did not reach much beyond α Arietis. At 7h. 45m. it was brightest; at 8h. it had faded out, possibly on account of mist in the air, as a fog set in about an hour afterwards. J. P. MACLEAR.

Chiddingfold, Surrey, March 4.

Contributions to Anatomical Journals.

PROF. HUNTINGTON, of Columbia University, has called my attention to a paragraph in an article on "A New Journal of Anatomy" in your issue of January 9 to which he, naturally, takes exception.

In justice to Prof. Huntington, I beg leave to state that he had no part whatever in the recommendation, acceptance or production of either of the papers on which your critic animadverts.

The first of these was accepted by one of my British co-editors and sent to me for publication, the author supplying the plates. For the second I, solely, am responsible.

The method of the higher criticism is not always trustworthy when its results can be checked by contemporary history.

ALEX. MACALISTER.

New Museums, Cambridge, February 14.

I REGRET to say that my statement concerning Prof. Huntington and the origin of the paper which I described was based on hearsay, and in face of Prof. Macalister's letter I can but tender Prof. Huntington my sincere apologies.

I am relieved to find that the author provided the plates.

February 26. THE WRITER OF THE REVIEW.

FURTHER DEVELOPMENTS IN WIRELESS TELEGRAPHY.

SINCE the article which appeared in NATURE last week was written, some further details concerning Mr. Marconi's Transatlantic signalling have been published, and also another success attained by the inventor has been announced. The information with reference to the latter point is contained in a telegram from the New York correspondent of the *Daily Telegraph*, which appeared in that paper on Monday last. Messages, it seems, were transmitted from Poldhu to the *Philadelphia*, whilst that ship, on board of which was Mr. Marconi, was on her way from this country to New York. Five messages in all were received, the first when the *Philadelphia* was at a distance of 250 miles from the Lizard, and the last on February 25, when the distance had been increased to 1551 miles. In addition, a signal of the much-talked-of letter "S" was received at a distance of 2099 miles. The news is confirmed by the following telegram from Mr. Marconi, which is contained in a letter from the Wireless Telegraph Co. to Wednesday's *Times*:—

"Health good. Received messages 1551 miles. Test letter at 2099. All on tape receiver. Records duly attested by ship's officers.—MARCONI."

The chief interest of these results lies in the fact that the received messages, including the signal "S," were recorded on the tape of the receiving apparatus, and not merely heard in the telephone, as was the case with the Transatlantic signal. Mr. Marconi must feel greatly gratified at thus having visible record of the success of his experiments in this instance, as it removes the possibility of the suggestion that he was deceived by the wish to hear being father to the thought that he heard. Messages were naturally only transmitted in the one direction, as the transmitting apparatus on board the *Philadelphia* was not so powerful as that at the Cornwall station.

The further details as to the Transatlantic signalling to which we referred above are published in an article on Mr. Marconi in this month's *Century Magazine*. This article, the proofs of which have been read by Mr. Marconi, contains an account of the development of wireless telegraphy, and is illustrated by a number of interesting pictures. We reproduce here a photograph of the transmitting station at Poldhu from which all the long-distance signals have been transmitted, which shows very clearly the group of twenty masts, each of which is 210 feet high. The power is obtained from an alternate-current generator of 38 horse-power. There is thus more than two hundred times as much power used as in the signalling apparatus installed on board ships using the Marconi system. It will be noticed that in the later work development has taken place rather along the lines of increasing the output of power than of using higher masts. Mr. Marconi, it is said, considers that a mast about 200 feet high is the most suitable from all points of view, and in some remarks, which we quote at the end of this article, states that he thinks that any desired distance could be bridged given sufficient power.

A good deal of objection is still raised on the question of syntony, and it is pointed out that although tuning has been obtained with sufficient accuracy to prevent interference, this does not prevent the picking up of messages by an outsider who should experiment with a

special view to finding the correct tune, or of the interference with signalling in a similar way. This fear is, however, somewhat imaginary, as it is doubtful whether such an enterprise would be commercially successful, and it is inconceivable that anyone should devote his energies to its realisation purely out of malicious rivalry. Even in war time, we think, it would hardly repay the labour, and, moreover, Marconi's system now promises to be of more use in peace than in war. It may be remarked, too, that syntony—especially syntony so thorough as that described by Prof. Fleming eighteen months ago, when two distinct messages were sent and received by the same transmitting and receiving wires—opens up the possibility of multiplex wireless telegraphy, which would be equivalent to a great increase in the speed of signalling.

We may finally quote some remarks made by Mr. Marconi on his arrival in America after his success with the experiments on the *Philadelphia*.

"I believe," he said, "that the distance at which a wireless message may be sent depends only on the power of the sending station. I think it possible to send a message entirely around the world, to start the message eastward around the globe, and to receive it at the same station from the westward.

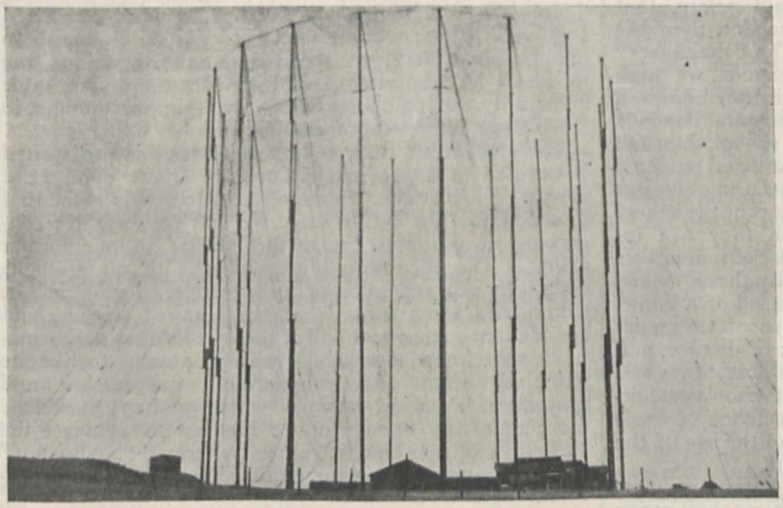

FIG. 1.—View of Poldhu Station, Cornwall, whence the signals came to Marconi at St. John's.

"I now know that the curvature of the earth does not in the least affect the waves. Many people who have reasons for hoping so have said that this would prove a fatal defect to the system, but it is not so. During the voyage I carried out a number of experiments which I had long wanted to make, but which I had never attempted before. You must pardon me for not disclosing their nature. All I can say is that they were eminently satisfactory to me." M. S.

THE METROPOLITAN HOSPITALS AND VIVISECTION.

WE have recently received the new edition of a pamphlet entitled "The Metropolitan Hospitals and Vivisection, a Guide for the Charitable in the Disposition of their Gifts and Bequests," by the Hon. Stephen Coleridge. The pamphlet begins with a prologue which consists of a short phrase snatched without any context from a speech delivered by the Home Secretary. Owing to the shorn character of this phrase, which stands out grotesquely framed with interpolations, we are unable to say what the Home Secretary really meant. The author, however, draws an inference which certainly is not justifiable, viz. that serious operations without anæsthetics necessarily involve the torture of animals. Whether this is so or not depends entirely upon what is meant by a serious operation and what is meant by torture, concerning neither of which is a word said. By torture we certainly do not mean mere momentary pain.

The main object of the essay is, however, threefold. In the first instance Mr. Coleridge, presumably satisfied, from his prologue, that the legalised torture of animals by so-called vivisectors actually takes place, and that no matter what its object may be is unjustifiable, classifies all metropolitan hospitals according to their supposed connection with vivisection. He further appeals to all those who have money to give, to enrich only those hospitals printed in plain type in his list, being the ones which at the present time are entirely free from vivisection and vivisectors. The second object of the monograph seems to be to denounce as diversion of charitable funds from their legitimate object any payment from the hospitals to the medical schools attached to them. There is also in addition to this an assumption that such payments are practically for the subsidy of vivisection so-called, and a further appeal to the charitable on this count. The third object is apparently to impugn the integrity of the committee for the distribution of King Edward's Hospital Fund.

First, then, according to Mr. Coleridge, the charitable should give only to those hospitals which at the time of their bequest are entirely free from all vivisection connections. It must be at once pointed out that this is a somewhat complicated affair, and will require very careful study upon the part of the donors, in that the staffs of hospitals change, and, further, a man of science once a vivisector is not always a vivisector. Since he does not vivisect for amusement, he does so only when he has a definite problem in his mind, and accordingly arranges a series of experiments capable of giving him a definite solution. From this it follows, as indeed the list in this pamphlet shows, that a hospital intimately connected with vivisectors one year may be entirely emancipated from them the next, and therefore that the terms of an anti-vivisection bequest will require alteration from year to year.

The hospitals at present free from all vivisection taint, according to the pamphlet before us, contain 4516 beds; of these 4500 beds, ethically, according to Mr. Coleridge, eligible for the gifts of the charitable, 1109, or practically one quarter, are devoted to lunatics or idiots. Now this fact surely should have been clearly stated, and also its corollary, viz., that should the charitable decide to support only those hospitals satisfying Mr. Coleridge's requirements for eligibility, one quarter of their subscription will be devoted to the maintenance of lunatics or imbeciles, extensive provision for which is already supplied out of the rates. Further, another fact of which the charitable, in Mr. Coleridge's sense, should be cognisant is, that of the remaining 3000 or so beds no less than 500, or approximately one-eighth of the original total, are devoted to the maintenance of incurables. Two-eighths of the subscriptions of the charitable should, according to Mr. Coleridge, go to lunatics, one-eighth to incurables. Of the remaining 2900 beds, 300 either belong to local cottage hospitals or are devoted to small-pox or other infectious diseases. The former hospitals

will receive a large measure of support, at least in many cases, from those locally interested in them, and accommodation for infectious diseases other than small local isolation hospitals is dealt with out of the rates. From this it follows that of any subscription given according to Mr. Coleridge's lines, little more than one-half will be devoted to what the average charitable man regards as the essential function of a hospital, viz. the treatment of acute medical and surgical disease and the rendering of the unfortunate subject of it capable of returning to earn his, and very often his family's, daily bread. We think it would have been fairer and of more real help to the charitable layman whom this pamphlet pretends to guide had these considerations been clearly set forth. Let him, then, now clearly understand that had he followed Mr. Coleridge's advice during, for instance, the year 1900, to which the figures in their entirety apply, and specifically stated that his money should go to no hospital connected with vivisection, practically half of it would have been "diverted" from the legitimate object of his charity.

To pass to a question which certainly does not possess the merit of novelty, viz. the so-called diversion of hospital funds to the medical schools attached to them, we would simply repeat what we have said before, that this is no diversion at all, no more diversion than the salary paid to a hospital gate-porter. The "managers" of the large hospitals are shrewd business men, we think more shrewd even than Mr. Coleridge, and they know full well that the efficacy of a large general hospital depends *inter alia* upon there being a medical school attached to it? The clinical teachers, demonstrators and students tend the sick and teach the nurses, thus securing efficient ones; the more purely scientific departments of the school help, each using the methods in which they are individually expert, in the elucidation of those obscure cases often demanding the technique of all. By these means the physician or surgeon becomes possessed of a knowledge of facts enabling him to adopt lines of treatment which mitigate pain, minimise the havoc of disease, and not seldom actually save life. Under the present regime these services are rendered by the medical schools gratuitously: sums granted towards the maintenance of these schools cannot be said to be diverted from the use of the sick; the sick get the full benefit of them.

If we now turn to Mr. Coleridge's impugnment of King Edward's Hospital Fund Committee, we shall arrive at some interesting deductions from the figures provided for our enlightenment which were not pointed out by the author. Mr. Coleridge has noted the fact that the allocation of the hospital fund grants per bed was greatest in the case of the hospitals possessing medical schools, and thus laboratories. In the case of the other hospitals, those which had upon their staff vivisectors received larger grants than those entirely unconnected with vivisection. *Post hoc propter hoc*, in other words, Lord Lister especially, and his colleagues to a less degree, have wilfully used King Edward's Hospital Fund for the purpose of endowing vivisection.

It is certainly to be assumed that King Edward's Hospital Fund was not intended for the endowment either of lunatic asylums or homes for the incurable, or local cottage hospitals, or local isolation or small-pox hospitals, which certainly ought to be provided for out of the rates. To no hospitals of this kind did the Committee, and we venture to think quite rightly, make any grant. We do not mean for one moment to infer that such institutions are not worthy of support, but the ordinary subscriber to a hospital fund does not include under that category either lunatic asylums or homes for incurable or dying patients. If, however, we exclude the above institutions from our calculations, how are Mr. Coleridge's figures affected? The facts are these: that (taking Mr. Coleridge's remaining figures as correct) hospitals with medical schools and laboratories attached received 5*l.* 8*s.* 9*d.*; hospitals with no medical schools, but connected in the special sense of the pamphlet with vivisectors, 4*l.* 14*s.* 2*d.*; and hospitals entirely unconnected with vivisection, 5*l.* per bed. In other words, while hospitals connected with medical schools received by a small amount the most per bed, those hospitals which were entirely unconnected with vivisection received more than those to the staffs of which so-called vivisectors were attached. There is, therefore, so far as the grant per bed is concerned, no ground for Mr. Coleridge's charges.

If we look into the matter more minutely we shall see that in the details of each hospital grant there is even less reason to suspect that vivisection had anything whatever to do with it. If we compare the maximum grants per bed in the hospitals as classified by Mr. Coleridge, we shall find the largest grant of all hospitals connected with vivisection laboratories was 8*l.*, or approximately 8*l.*, per bed, given to Guy's, a hospital in need of funds, and one, of course, doing magnificent work. If we take two hospitals entirely unconnected with vivisection, we find in the case of the N.W. London Hospital a grant of 10*l.* per bed, and in the case of the Royal Free Hospital a grant of 9*l.* per bed. How can it be argued, in the face of these figures, that preference was given to hospitals connected with vivisection *qua* vivisection? We do not wish to impugn Mr. Coleridge's motives, but the ingenious way in which he has attempted to mislead the charitable layman by the pamphlet before us is, in our opinion, in the highest degree reprehensible.

The end of this document in which truth is so distorted is devoted to a personal defamatory attack upon Lord Lister. This attack, we are pleased to see, is somewhat modified for the better since we last reviewed it; concerning it we must refer the reader to our former article. The monograph concludes with an epilogue consisting of a repetition of an invective, couched in Mr. Coleridge's most offensive terms, against science, and sounds like some papal bull of the middle ages anathematising that knowledge which was eventually to liberate mankind from filth, superstition, suppression and ignorance. Medical science, which perhaps has done more than any agency under Heaven to alleviate the sufferings of mankind, is ruthlessly termed "malignant." Invective is not argument, neither is calumnious opprobrium logic.

The charitable subscriber to London hospitals will see to what "diversion" his subscriptions will be subject if he follows the advice of Mr. Coleridge. It is to be hoped, and indeed to be expected, that he will give as he has done before, leaving the disbursement of his bequests to representatively elected committees of experts who, neither prompted by political motives nor influenced by misplaced and maudlin sentimentality, will assuredly allocate them to the most urgent wants of the sick.

THE PROPOSED BRITISH ACADEMY.

THE following text of the petition presented to the Privy Council by the council of the Royal Society in favour of the establishment of a British Academy appeared in the *Times* of February 27:—

TO THE KING'S MOST EXCELLENT MAJESTY IN COUNCIL.

The humble petition of the President and Council of the Royal Society.

Showeth—

That your petitioners pray that the petition which has been presented to His Majesty in Council praying for the grant of a charter of incorporation to "The British Academy for the Promotion of Historical, Philosophical and Philological Studies" be granted.

Your petitioners are led to take this step both for the general reason that the granting of such a charter will, in their opinion,

be for the great good of learning, and also for the special reason set forth in the following statement :—

In 1899 an International Association of Academies, composed of the leading learned bodies of many countries, was formed, the Royal Society taking an active part in its formation. Since the various studies cultivated by the constituent academies could be readily divided into two categories—(1) those of mathematical, experimental and natural science, and (2) those of philology, history and philosophy—the association established within itself two sections, one for the former the other for the latter studies, and drew up statutes in accordance with this division.

The Royal Society is, at the present time, concerned with studies of the former category only ; and since no other learned body of the United Kingdom dealing with the studies of the other category belongs to the association, it has come about that while most other countries are represented in both sections, either by two academies or by an academy taking charge of studies of both categories, this country is represented in one section only.

In other words, in this country there does not exist, as in most other countries, an academy or other organisation of the rank of the several academies constituting the association in question, charged with the duty of fostering studies of the second category. The Royal Society, therefore, thought it to be its duty to bring this fact, regrettable on general grounds, quite apart from representation in the International Association of Academies, to the notice of certain persons in this country eminent in those studies.

A correspondence with these eminent persons resulted in the Royal Society being invited to consider how this regrettable state of things could be remedied, and in particular whether the Royal Society was able and willing to include the studies in question within its sphere of action.

The president and council of the Royal Society appointed a special committee to consider and report upon the matter, instructing the committee not to advise the president and council as to what action the society should take, but simply to state the reasons for and against the several suggestions put forward in the correspondence above mentioned.

The committee after prolonged investigation and consideration made a report of the desired character, stating incidentally its opinion that under the charters of the society the studies in question could, if it were deemed desirable, be taken charge of by the society itself.

The report of the committee was discussed at a special meeting of the Fellows, and the president and council, after carefully considering the report and the discussion at the above meeting of Fellows, adopted a resolution to the effect that they were of opinion that the studies in question ought to be taken care of by some academic organisation, and that this should be effected, not by the Royal Society taking charge of these studies, but by the establishment of some other body.

The president and council believe that the proposed academy, for which a petition has been presented, may with confidence be expected to take care of and promote the studies in question efficiently and successfully. They have reason to think that the establishment of an academy taking charge of such studies will be welcomed by all the constituent academies of the association, and they are prepared to offer it if established the cordial and friendly support of the Royal Society.

They therefore respectfully urge that the petition be granted.

And your petitioners will ever pray.

NOTES.

THE Croonian lecture of the Royal Society will be delivered on Thursday, March 13, by Prof. A. Gamgee, F.R.S., on the physico-chemical properties of hæmoglobin, its compounds and derivatives.

THE seventy-second annual meeting of the British Association will be held at Belfast on September 10–17, under the presidency of Prof. James Dewar, F.R.S. The presidents of the sections will be as follows :—A (mathematical and physical science), Prof. J. Purser ; chairman of department for astronomy and cosmical physics, Prof. A. Schuster, F.R.S. ; B (chemistry), Prof. E. Divers, F.R.S. ; C (geology), Lieut.-General C. A. McMahon, F.R.S. ; D (zoology), Prof. G. B. Howes, F.R.S. ; E (geography), Colonel Sir T. H. Holdich, K.C.B. ; F (economic science and statistics), Dr. E. Cannan ; G (engineering), Prof. J. Perry, F.R.S. ; H (anthropology), Prof. A. C. Haddon, F.R.S. ; I (physiology), Prof. W. D. Halliburton, F.R.S. ; K (botany), Prof. J. Reynolds Green, F.R.S. ; L (educational science), Prof. Henry E. Armstrong, F.R.S. The evening discourse on September 12 will be delivered by Prof. J. J. Thomson, F.R.S., on "Becquerel Rays and Radio-activity" ; and the discourse on September 15 will be on "Inheritance," by Prof. W. F. R. Weldon, F.R.S. The lecture to the operative classes, on September 13, will be by Prof. L. C. Miall, F.R.S, on "Gnats and Mosquitoes."

M. BAILLAUD has been elected a correspondant of the section of astronomy of the Paris Academy of Sciences in succession to the late M. Souillart.

ONE of Prof. J. C. Ewart's zebra-pony hybrids will be exhibited next week, March 13 and 14, in the Agricultural Hall, Islington.

THE Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, has appointed a departmental committee to inquire into and report as to the present position and future prospects of forestry and the planting and management of woodlands in Great Britain, and to consider whether any measures might with advantage be taken, either by the provision of further educational facilities or otherwise, for their promotion and encouragement. The committee consists of Mr. R. C. Munro-Ferguson, M.P. (chairman), Sir John F. L. Rolleston, M.P., Mr. E. S. Howard, C.B., Prof. W. Schlich, C.I.E., Colonel F. Bailey, R.E., Prof. J. R. Campbell, Mr. J. H. Lewis, M.P., Mr. George Marshall and Dr. W. Somerville.

MR. R. H. TIDDEMAN, M.A., F.G.S., who joined the staff of the Geological Survey, under Murchison, in 1864, has just retired from the public service.

A MEETING of the Engineering Standards Committee was held at the Institution of Civil Engineers on March 4, to hear evidence on the question of the standardisation of locomotives and the specifications for the materials used in their construction. The questions down for consideration were :—(1) Is it desirable to proceed with the standardisation of locomotives ? (2) If so, should this be a question of general design or only of component parts ? (3) How far would it be of practical value to have standard specifications defining the quality of the materials used in locomotive construction ?

ON Tuesday next, March 11, Prof. E. B. Poulton, F.R.S., will deliver the first of a course of two lectures at the Royal Institution, on "Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects." The Friday evening discourse on March 14 will be delivered by Prof. Silvanus P. Thompson, his subject being "Magnetism in Transitu" ; the succeeding discourse on March 21 will be given (in English) by Geheimrath Prof. Otto N. Witt, of Berlin, on "Recent Developments in Colouring Matters."

THE annual dinner of the Royal School of Mines was held at the Hotel Cecil on Friday last, Mr. Bedford McNeill being in the chair. In proposing "The Mining and Metallurgical Industries," the chairman alluded to the magnitude of the two industries connected with their profession, and said that mining in the past had been largely carried on by men who did not have the advantage of educational facilities, who had to learn largely, if not solely, in the school of experience. In spite of the improvement which had been effected in Cornwall, it had to be admitted that the conditions of practical mining in Cornwall were not fully representative of those higher developments which had been achieved in our colonies and in foreign countries. Mr.

W. Whitwell, in responding, spoke of the severe competition which the iron trade was experiencing in America, and attributed the success of the American iron trade in a great degree to the opportunities afforded in that country for education.

A FEW of the items in the Civil Service Estimates for the year ending March 31, 1903, are of interest in their connection with science and education. In the class of Salaries and Expenses of Civil Departments, the estimate for the Board of Agriculture, England, is 5378*l.* less than last year, but the Department of Agriculture, Ireland, has an estimate increased by 17,439*l.*, of which 4110*l.* is required for salaries and wages in connection with institutions of science and art, 300*l.* for the Royal College of Science for the purchase of books, specimens, &c., 1000*l.* for annual grants for science instruction, and 5800*l.* for grants in aid of day secondary schools. In the class of Education, Science and Art, there is a net increase of 235,446*l.*, of which extra amount the Board of Education will receive 170,884*l.*, while scientific investigation, &c., will obtain a net increase of 15,242*l.* The latter estimate includes an additional grant of 3000*l.* towards the cost of adapting and equipping Bushy House for the purpose of the National Physical Laboratory, this amount completing a total grant of 19,000*l.* There is also a grant of 16,000*l.* as the first instalment on account of a total sum of 42,000*l.* estimated to be required in a period of three years in connection with the international scheme for investigating problems connected with the fisheries of the North Sea and adjacent waters.

TO celebrate the election of M. Bouquet de la Grye to the presidency of the Paris Academy of Sciences, the Artistic Union of Auvergne has had a medal designed and struck, and

Medal presented to M. Bouquet de la Grye.

it was presented to him with an album containing expressions of esteem at a banquet held on February 13. The face and back of the medal are illustrated in *La Nature*, and the views are here reproduced. Colonel Laussedat presided at the banquet and referred in appropriate terms to the numerous scientific investigations of his colleague, from his first work in hydrography and on the transit of Venus expedition to his researches on the influence of the moon and his great scheme for making Paris a seaport. In reply, M. Bouquet de la Grye expressed himself conscious of the honour done him by the Academy of Sciences, and gratified at the celebration of it by his friends.

THE three very interesting papers on electric shocks which were read before the Institution of Electrical Engineers last Thursday direct attention to a subject of which very little seems to be known from either the electrical or the physiological side. Mr. Aspinall quoted a number of cases in which death might have been expected, but did not occur, and formulated a list of pertinent questions to which definite and certain answers would be of the highest value. Mr. Trotter gave a practical demonstration that the liability to shock at 500 volts is very much less than is generally believed. With dry boots and clothes he showed that one could quite safely stand or lie on an earthed rail whilst handling a live conductor at 500 volts. In other words, it is quite safe to fall across the rails of, say, the Central London Railway provided bare skin does not touch *both* the earthed and the live rail. Unfortunately, in a case of accident one cannot arrange the conditions for safety, and, moreover, a sudden unexpected shock may have much worse effects than one taken carefully and deliberately. The discussion of the papers on March 13 is likely to be of great interest. What is, perhaps, most desirable is that some definite information should be forthcoming on how best to restore life in a case of apparent death from electric shock.

AN interesting account of the electrical manufacture of carbon bisulphide is given in a recent number of the New York *Electrical Review*. The furnaces consist of tall stacks which are filled with charcoal; sulphur is fed in at the bottom of the furnace and allowed to rise, when molten, as high up the electrodes as is considered advisable. The molten sulphur acting as an insulator, the height to which it rises serves to regulate the current. Carbon bisulphide vapour is led off at the top of the furnace. The plant consists of two furnaces, each having a capacity of 20,000 pounds per day. One furnace lies idle, for cleaning, &c., whilst the other is running; it is said that a furnace can be run continuously for several months. The power is derived from alternators direct-coupled to water wheels, and at present only half the available water-head is being utilised. The larger output obtainable when the full water-head is used is likely to be considerably in excess of the demand.

WE have received an attractive pamphlet from the Acheson Graphite Company (Niagara Falls), which contains some useful information and data relating to the electrodes which they manu-

facture. The electrodes are first made up in amorphous carbon, which is then converted to graphite by baking at a very high temperature in the electric furnace. It is claimed that the conversion to graphite is complete. These electrodes are especially suitable for electrolytic purposes on account of their high conductivity and low porosity, and also, a recommendation which will appeal to experimentalists, on account of the ease with which they can be machined and worked. It is also not unlikely that the use of graphite electrodes in metallurgical processes will extend. Both in metallurgical and electrochemical work the quality of the electrodes is of the first importance, making in many instances all the difference between success and failure.

DR. C. JENSEN, of Hamburg, has contributed to the *Meteorologische Zeitschrift* for December last an interesting paper on the subject of atmospheric polarisation. The author reviews all the principal theories and discoveries from those of Arago in 1809 to the recent important works of Dr. Pernter relating to the analogy of various turbid media with the blue light of the sky. The author considers that the observation of atmospheric polarisation should be of use in weather prediction, as showing approaching cloudiness some hours before it is visible by other means, and also as showing whether the sky is clear or otherwise above a stratum of fog.

THE "campylograph" invented by Père Marc Dechevrens for mechanically describing certain ornamental curves is the subject of a paper by its inventor in *Cosmos* for February 22, and of a pamphlet, published in Brussels, by Père Potron, who deals with the equations of the curves it describes. The machine, to which the name campylograph is given, is an arrangement for compounding the projections, in two mutually perpendicular directions, of two circular motions, and as such it can be made to trace Lissajou's curves exactly, the amplitude of the component vibrations remaining constant instead of decaying as is the case with compound pendulums. Moreover, the table carrying the paper can be rotated and a variety of figures thus obtained, including the epicycloids and hypocycloids, and also curves similar to those given by a harmonograph with clockwork table, but without the gradual decrease in amplitude. It should, however, be remembered that numerous machines have at different times been designed for drawing various classes of ornamental curves, and it seems as likely as not that something practically identical with the "campylograph" may have been previously constructed.

SEVERAL papers tending to raise doubts regarding the well-known laws of electromagnetism for bodies in motion have already been noticed in these columns. M. R. Blondlot writes on this matter in the *Journal de Physique* for January. If a current of air is moving parallel to the axis of z in a magnetic field the lines of force of which are parallel to the axis of x, then, according to Hertz and Lorentz, an electromotive force ought to be set up in the negative direction of the axis of y, and if the two plates of a condenser are placed perpendicularly to this direction and connected by a wire so as to bring them to the same potential, they ought to become charged and to remain charged when they are separated. According to M. Blondlot, however, the only observable effects are such as can be accounted for by accidental causes, and are small in comparison with those required by theory. The author further remarks that by an application of the principle of action and reaction it would appear to follow that a displacement current in air exerts no magnetic action, and according to this view the discharge of a condenser is magnetically an open current. Or if this contradiction of Maxwell's theory be not admitted, we should have to abandon the principle of reaction.

THE spark spectra of those elements which are gaseous at ordinary temperatures have been extensively investigated, but little research has been hitherto done on the arc spectra of gases. Mr. O. H. Basquin has recently published, in the *Proceedings* of the American Academy of Arts and Sciences (vol. xxxvii pp. 161–174), an account of his research on "The Arc Spectrum of Hydrogen." In his apparatus, one electrode was made to rotate quickly, this preventing the welding together of the electrodes and also throwing the hot gases to one side. That part of the flame of the arc thus separated from the poles was very free from continuous spectrum, and he was thus better able to study the spectrum lines than if a stationary arc were used. The arc was enclosed in a comparatively air-tight brass "hood," through which a stream of electrolytically-prepared hydrogen was continually passing. The light from the arc passes through a lens fixed at the end of a brass tube fitting into the wall of the hood. The arc spectra in hydrogen of aluminium, copper, magnesium, coin-silver, sodium, tin and zinc were examined both visually and photographically. Of the well-known series of hydrogen lines seen in its low-pressure spark spectrum and in the spectra of the hotter stars, $H\alpha$ and $H\beta$ are well shown visually in the case of all metals except Na; the majority also show $H\gamma$, but $H\delta$ is rarely seen. $H\alpha$ is sharp and well defined, the others broad and hazy. In the photographic spectra, $H\beta$ and $H\gamma$ are seen in the case of all metals except Na, while $H\delta$ shows in the spectra of tin, silver and copper. A small dispersion spectrum of tin shows $H\epsilon$ also. The weaker hydrogen lines more refrangible than $H\epsilon$ have not been traced, this being probably due to the inordinate width of the lines, those detected averaging about twenty-five tenth metres. All the metals except tin give a characteristic set of lines which do not occur in the arc spectrum in air of the corresponding metal. These new lines do not seem to bear any particular relation to the spark lines of the respective metals, and the author supposes them to be due to compounds of hydrogen with the metals formed in the arc. No new lines have been found which can with certainty be attributed to hydrogen. At the end of the paper an interesting discussion is given of the general effects of the hydrogen atmosphere on the arc and its spectrum.

THE first of the international balloon ascents for the current year took place on January 9. At Chalais-Meudon the ascent was at 8h. a.m.; temperature at starting 1°.C., maximum height reached 11,405 m., minimum temperature −63°·1. At Trappes two ascents were made; the heights reached were 15,000 m., temperature −61°·4, and 15,670 m., −62°·2. At Strassburg a height of 8100 m. was reached; temperature at starting −4°.4, minimum −42°·8. One of the manned balloons at Berlin remained up for nearly twenty-nine hours, and the following readings were taken:—at starting, 3°·9; at 3490 m., −4°·3; at 4850 m., −15°·1. While travelling eastward the same stratum of cloud was always observed, the upper edge of which continually increased in height. Above the cloud an inversion of temperature occurred and a sudden change of wind from west to about north-west. Three balloons ascended from Vienna; in one of the manned balloons a temperature of −10° was recorded at 4100 m. Ascents were also made from Pavlovsk (St. Petersburg) and Mr. Rotch's observatory, Blue Hill, in the United States. Except at St. Petersburg, the balloons ascended in an extensive area of high barometric pressure, the centre of which lay over the Alps.

IN *Symons's Meteorological Magazine* for February, a map is given showing the places, so far as at present ascertained, at which deposits of yellowish-pink dust were observed on January 22 and 23. It attracted attention over practically the whole of Cornwall, near the western border of Devon, and at a few points in Somerset, the south of Gloucester and Glamorgan.

Specimens of the dust have been microscopically examined by competent authorities, and it appears to be of the same nature as that which is often carried over from Africa to Europe. Further particulars are needed for the purpose of a more detailed account. Dr. H. R. Mill gives some particulars respecting the high barometer readings of January last. The highest pressure before recorded in the British Isles was 31·108 inches, at Ochtertyre, on January 9, 1896, but the reading at Aberdeen on January 31, namely 31·11 inches, as given in the *Daily Weather Report*, was apparently a trifle higher than the previous record. Dr. Mill directs attention to the fact that the popular belief that a high barometer involves calm weather was somewhat rudely shaken by the easterly gale which raged in the Channel from January 31 to February 2—under the influence of the low-pressure area in southern Europe.

THE September issue (vol. vi. art. 1) of the *Bulletin* of the Illinois State Laboratory contains the first part of a history of the dragon-flies of that State by Messrs. Needham and Hart. The authors state that these insects, together with their near relatives the May-flies, are the isolated remains of an extremely primitive group, the members of which have become specialised along certain lines.

WE have received from the author, Mr. F. Finn, a copy of an interesting paper on the cage-birds of Calcutta, which appeared in the *Ibis* for July last. The taste for keeping birds in confinement has been prevalent for centuries among the natives of India, although now somewhat on the decline, the author citing evidence to show than an Australian cockatoo was imported in the time of Jehangir. It is satisfactory to learn that, on the whole, the treatment of these cage-birds is good. The natives display especial capacity for keeping soft-billed insectivorous species in confinement; and as an instance of the interest taken in birds, the author mentions that when a living bird-of-paradise was for the first time received in Calcutta, the then Amir sent a special messenger all the way from Cabul to ascertain whether it was really the bird he knew so well by report.

IN the course of a description of a new "agricultural ant" of the genus Pogonomyrmex, published in the *American Naturalist* for February, Prof. W. M. Wheeler takes occasion to dispose, once and for all, of the myth that certain ants of this group sow and reap the so-called "ant-rice." If the nests of the species in question be observed at the proper season, it will be seen that the workers often carry out from the store-chamber grains of ant-rice which have sprouted to deposit them in a heap some distance off. These seeds frequently, of course, take root and grow, and since the ants feed mainly upon such grass-seed, it is no matter for surprise that "ant-rice" should predominate in the ring of vegetation surrounding the nest. To state, however, that the ant, "like a provident farmer, sows this cereal and guards and weeds it for the sake of garnering its grain is as absurd as to say that the cook is planting and maintaining an orchard when some of the peach-stones she has thrown into the yard chance to grow into peach-trees." The myth will, however, probably be hard to kill, since it is supported, not only by the authority of Darwin, but is repeated in Lord Avebury's well-known work on ants.

THE oviparous species of peripatus form the subject of a long article (illustrated with a coloured plate) by Dr. A. Dendy in the February number of the *Quarterly Journal of Microscopical Science*. The fact that an Australian species of peripatus (using this term in a general sense) lays eggs was announced by Dr. Dendy in NATURE of February 14, 1889; and although, largely owing to some confusion in the identification of species, the statement was received with considerable scepticism, the author has now been enabled, not only to fully demonstrate its truth, but to show that the phenomenon occurs in a second Australian species. It is certainly a very remarkable circumstance that while the other known species of these primitive arthropods are viviparous, these two forms (now designated Oöperipatus) should lay eggs; and it would be of the greatest interest could the reason for the departure from the general rule be accounted for. Dr. Dendy, after describing the anatomy of the egg-laying species in considerable detail, discusses the phylogeny of the whole group.

TO the same journal Messrs. Bradford and Plimmer communicate an important paper on the organism infesting the blood of animals suffering from tsetse-disease. This parasite, for which the authors have proposed the name *Trypanosoma brucei*, is fully described and its life-history sketched. Many experiments have been made with the view of discovering whether any animals are immune against this parasite, but so far without success. The authors add, however, that there is probably in all animals some attempt at resistance to its attacks, and that this is effected by means of phagocytes. The parasite is closely allied to one affecting sewer-rats, which belongs to the same genus. The rat Trypanosoma does not, however, in the least protect the animal containing it against the tsetse parasite. It may be added that a beautiful series of greatly enlarged models illustrating the life-history of the latter is now exhibited in the Natural History Museum.

IN the last *Bollettino* of the Italian Seismological Society (vol. .vii. No. 5), Dr. Cancani describes an interesting series of earthquakes felt during April and May, 1901, in the district round Palombara Sabina, near Rome, the strongest of which (on April 24) caused some damage to buildings. The focus of this earthquake being evidently at a very slight depth, Dr. Cancani ascribes the shocks to readjustments of the superficial strata due to the erosion of the underlying rock. From records obtained at Rome, Padua and Casamicciola, the mean velocity of the earth-waves was found to be 4·85 km. per second.

THE *Journal of Geography*, a new American monthly, succeeds the *Journal of School Geography* and the *Bulletin* of the American Bureau of Geography. The January number contains a paper on useful products of the century plants, by W. B. Marshall, and the first instalments of papers on field work in physical geography, by Prof. W. M. Davis, and on the trade and industries of western South America, by Emory R. Johnson. A special feature is "Geography Current," a series of notes and reviews on subjects bearing on various branches of geography.

THE *Journal* of the Society of Arts for February 14 contains a valuable paper by Commander R. Whitehouse, R.N., on the Uganda Railway and the survey of Lake Victoria Nyanza. On the opening of the whole line, the journey from Mombasa to Port Florence will take two and a half days, and the steamer journey from Port Florence to Mengo another day, as against seventy days by caravan. The railway has already opened up a large amount of country, and until other railways are constructed it must command the trade of the whole of that part of Central Africa.

THE Berlin Gesellschaft für Erdkunde begins the year with a change in the form of its publications. The *Zeitschrift* and the *Verhandlungen* are now combined in a single journal, which retains the name of the former, and is to appear ten times a year. The January number contains, among other things, papers by Herr O. Neumann, on a journey from the Somali coast through southern Ethiopia to the Soudan, by Herr K. Sapper, on the physical geography of Honduras, by MM. E. Reclus and Valère Maes, on the "disque globulaire" (the

admirable maps on natural curvature produced recently under M. Reclus' direction), and a report by Dr. E. von Drygalski, dated Cape Town, on the progress of the German South Polar Expedition.

THE Queensland Geological Survey, under the direction of Mr. William H. Rands, has forwarded *Bulletins* Nos. 13 to 17 (1901). In these we have additional notes on the Cretaceous fossils of Queensland by Mr. Robert Etheridge, jun., and reports on mining districts by Mr. Rands and Mr. B. Dunstan. Referring to the Mount Morgan mine, Mr. Dunstan remarks that it is impossible to tell by appearances whether the stone is rich or poor, as of two samples which might be absolutely the same in texture, colour, structure, specific gravity and visible mineral constituents, one would perhaps yield as many ounces of gold to the ton as the other would pennyweights. In an account of Diglum Creek, in the Gladstone district, Mr. Dunstan describes the production of garnet, wollastonite, epidote and chert where granite has come in contact with limestone. We have also received folio reports on the Gympie gold field by Mr. Rands, and on the Hamilton, Coen and Jordan Creek gold fields by Mr. Lionel C. Ball. Permo-Carboniferous coal-bearing beds occur in the valleys of the Dawson and Mackenzie rivers, and outcrops of anthracitic coal have been traced by Mr. Dunstan. The Dawson coal, which is a ten-foot seam, is reported to be suitable for general purposes and as absolutely smokeless. In central Queensland there is an area of upwards of 5000 square miles which may be coal-bearing; hence a closer and more detailed examination of this region is desirable.

MESSRS. CASSELL AND CO. have commenced the publication, in fortnightly parts, of "Familiar Wild Flowers," by Mr. F. E. Hulme The complete work contains 280 coloured pictures, including 40 which have been specially prepared for the new edition, and will be completed in twenty-four parts at sixpence each.

MR. W. WESLEY, of Essex Street, Strand, sends us a "Catalogue of Zoological Literature" (No. 140, in two parts). As it includes the late Mr. S. P. Hanley's conchological library, as well as the entomological library of Mr. H. Christoph and the works on Cœlentera collected by the late Prof. G. J. Allmann, it is worth careful attention on the part of those interested in such subjects.

MORE than forty years after his first determinations of the transport numbers of the ions in the passage of electricity through solutions of electrolytes, W. Hittorf describes, in the *Zeitschrift für physikalische Chemie*, some interesting experiments relating to the influence, exercised by the diaphragms separating the anode and kathode solutions, on the measured values of these transport numbers. When a porous clay diaphragm is used, the volume of the solution at the anode decreases in all cases investigated. When, however, an animal membrane separates the anode and kathode solutions, it is found that with solutions of the chlorides of potassium, ammonium and sodium, cataphoresis takes place in the direction of the current, whilst with dissolved chlorides of the alkaline earth metals and of cadmium, the cataphoric effect is in the opposite direction. In the latter case, the volume of the solution at the anode increases. At the animal membrane, apparently a separation of the original solution into a solution more concentrated and one more dilute takes place. This behaviour of animal membranes results in considerable errors in the determination of transport numbers, and Hittorf is able to account for the deviations between the results obtained by himself in the late fifties and those more recently obtained by other investigators who have not made use of animal membranes in their experiments.

THE additions to the Zoological Society's Gardens during the past week include a Pluto Monkey (*Cercopithecus leucampyx*, ♂ from Uganda, a Leopard Tortoise (*Testudo pardalis*) from British East Africa, presented by Major C. Delmé Radcliffe a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. T. W. Dye; three Bengal Red-vented Bulbuls (*Pycnonotus bengalensis*) from India, presented by Mr. Frank Finn; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, two young Lions (*Felis leo*, ♂ ♀) from British East Africa, four Prjevalsky's Horses (*Equus prjevalski*, ♂ ♂, ♀ ♀) from Mongolia, a Red Lory (*Eos rubra*) from Moluccas, a Green Conure (*Conurus leucopthalmus*) from Trinidad, an Angulated Tortoise (*Testudo angulata*) from South Africa, deposited; an English Wild Cow (*Bos taurus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF THE CHROMOSPHERE.—At the recent meeting of the Astronomical and Astrophysical Society of America, held at Washington, Mr. S. A. Mitchell read a paper on the observations made during the total solar eclipse in Sumatra on May 18, 1901. The spectrum photographs were obtained with an objective grating spectrograph; the grating had a ruled surface $3\frac{1}{2} \times 5$ inches, with 15,000 lines to the inch, the objective being a quartz lens of a little more than $3\frac{1}{4}$ inches aperture and about 72 inches focal length. Light from the eclipsed sun was reflected into this instrument by a cœlostat. The adjustments were such as to ensure a "normal" spectrum, this being the case when grating and photographic plate were each perpendicular to the diffracted beam. The first order was employed, from λ 3000 to λ 6000. Although the sky was never clear during the period of totality of 5 min. 41 secs., eight exposures were made—one before and one just after totality for the cusp spectra, one at first and one at second flash, and four with varying exposures during the total phase. The second flash appeared fully exposed, and the plate has been carefully measured. The dispersion is such that from H to H_ϵ occupies a length of 95·4 mm., *i.e.* 1 tenth-metre corresponds to about 0·1 mm. In the region mentioned, Hβ to H_ϵ, 363 lines have been determined. Of these, 269 have been identified with lines on Rowland's map.

Tables have been made of the ratios between the intensities of lines in this flash spectrum and in the ordinary Fraunhofer spectrum, and also of the ratios of the number of lines of each element identified to the whole number of solar lines for that metal. Both these sets of ratios appear to show systematic variation, and they are grouped into three classes, their behaviour being considered in conjunction with the atomic weights of the elements.

The variations in intensity are considered as chiefly due to the various heights to which the different metals ascend in the chromosphere. It is thought that the metals of group II. extend very high and are nowhere very condensed, and their flash lines will be true reversals of the corresponding solar lines. The metals of groups I. and III. are denser near the sun's surface and do not extend so high, and hence their flash lines are to be regarded as only partial reversals of the Fraunhofer lines. These facts lead the author to conclude with a renewal of faith in the existence of the "reversing layer."

PHOTOGRAPHIC DETERMINATION OF LONGITUDE.—In the *Comptes rendus*, vol. cxxxiv. pp. 387-389, M. G. Lippmann describes a new method for the photographic determination of longitude, using an apparatus originally designed by M. Fabry (*Bulletin Astronomique*, p. 148, 1895) for visual observation only. The arrangement was extended by M. Lippmann so as to permit of photographic registration, and described in *Comptes rendus*, cxxxiv. pp. 205-208. The principle of the method consists of making simultaneous records of the zenith at each station, the required longitude being the difference in right ascension observed. The apparatus is similar to that employed for nadir observations. Light from an adjustable horizontal collimator falls on a half-silvered mirror inclined at 45° to the vertical, and is reflected to the surface of a bath of mercury. After its reflection from the mercury, the light is again reflected from the mirror into the collimator, giving an image of the slit or cross-wires which may be adjusted to coincide with the source.

When this is done, a telescope is employed to photograph the region about the zenith as reflected from the upper surface of the silvered mirror. In this position the photographic telescope will lie in the same direction as the fixed collimator, and thus it can be arranged to have a suitable exposing screen, by which, at any instant, a short exposure is given to a strong light placed near the collimator slit, which will give an image of the slit superposed on the region near the zenith, the centre of this image indicating the instrumental zenith. All that remains to be done is to provide a duplicate apparatus at a second station, and by operating the exposing shutters of their respective collimators by electric means, the zenith of each place will be automatically recorded. The difference of longitude between the two stations will be equal to the difference of the right ascensions of the two collimator images. The chief corrections will be owing to the possible prismatic form of the reflecting mirror and the catalogue errors introduced in computing the right ascensions.

INDIAN SURVEYS.[1]

THE Report on Indian Surveys for the year 1899–1900 is now before the public, and the resolution of the Government of India which concludes this report pronounces it to be one which reflects great credit on the "able and effective administration" of Colonel St. G. Gore, R.E., the present Surveyor-General. Field operations were carried on by one double and fifteen ordinary parties and four detachments. Eight of these parties were employed on topographical (including geographical) surveys, only one on trigonometrical work, and the remainder included cadastral and traverse surveys and special geodetic investigations. A large area of forest survey was also completed. The total outturn amounted to nearly 150,000 square miles, of which more than 120,000 square miles were "reconnaissance" or geographical surveys, on the ¼-inch or smaller scales, in Burma and on the north-west frontier. The total area of rigorous surveys on all scales was 29,418 square miles. The normal scale for topographical surveys in India is 1 inch = 1 mile, and the cost of these surveys (which are based on rigid triangulation) is from 25 to 30 rupees per square mile—a cost which compares favourably with that of American surveys conducted under similar physical conditions, but with a very different staff of employés. The cheapness of Indian surveys is doubtless due to the general employment of skilled native labour. In this connection it is satisfactory to note that natives are now being instructed to triangulate and that the magnetic party which has been lately inaugurated will be placed under a native observer.

The general increase in the outturn on that of the previous year is due to the accession of an unusually large area of geographical mapping, full details of which are not published. Topography, conducted on rigorous methods, was chiefly confined to Burma and Sind, two countries which, whilst they balance each other geographically on the east and west, afford a useful contrast for comparison of cost rates and methods of survey. Of the special work undertaken by the Department, that which resulted in a comparison of the values of level deflection by means of observed latitudes on Great Arc stations receding gradually from the Himalaya is most instructive, and special attention is called by the Government of India to Captain Lenox Conyngham's discussion of the results obtained. Experiments were made with the Bridges-Lee photo-theodolite, and with the Jaderin base measuring apparatus which promises, if not to supersede the complicated adjustment of compensation bars altogether, at least to simplify the process of measuring bases for all but the most rigidly accurate geodetic purposes. The former is pronounced to be a very promising auxiliary to the plane table (especially in mountainous countries), "but it will never supersede it." This, it may be remarked, is nearly coincident with the opinion of Canadian surveyors who have tested photo-topography far more exhaustively than has been done in India. As regards the Jaderin apparatus, an unfortunate uncertainty about the value of the coefficients of expansion in the metals forming the tape has deferred an expression of opinion on its success or otherwise.

Record is made of a most useful invention in the printing office by a R.E. foreman which enables the process of photography to be eliminated from the cumbersome method of map reproduction by photo-zincography. There can be little doubt of the value of the invention, which is fully described, and which has been patented in India. It has already enabled the printing office to deal with a vast number of maps in excess of the normal outturn. We are glad to observe that the invention has met with prompt recognition by the Government of India. The report contains three or four excellent photogravure illustrations, one of which is a suggestive view of a railway bridge on the Mandalay-Kunlon line, which is now under construction.

The map illustration is perhaps the most unsatisfactory feature in the report. One map at the commencement of the volume purports to show the "progress of the Imperial surveys," and exhibits a special colour to denote "geographical reconnaissance on various scales." According to this map a large area of the Madras province has never even been "geographically reconnoitred"—which is a very astounding fact if it is true—for it is blank white paper. And the fact that no surveys are shown in Baluchistan must be due either to an affectation that British Baluchistan and Quetta have nothing to do with India, or else it is a deficiency in the illustration, for it leaves an enormous area of the outturn of the Department which is included in the body of the report absolutely unaccounted for. The triangulation chart adjoining shows a very satisfactory-looking series extending to Kandahar from the Indus, and another series reaching half way through Makrán. Triangulation usually carries topography on its back, and doubtless it does so in the present instance. Why the extent of transfrontier "geographical reconnaissance" (to say nothing of exact detailed topography) should not be shown in the chart it is difficult to imagine.

[1] General Report of the Operations of the Survey of India Department, 1899-1900.

MILROY LECTURES ON TYPHOID FEVER.

IN his second and third (final) lectures at the Royal College of Physicians, Prof. Corfield gave detailed descriptions of a number of outbreaks of typhoid fever which had been traced to specific contamination of drinking water, and exhibited a table which he had prepared demonstrating the fact that during the ten years 1891 to 1900 (with the exception of 1897) typhoid fever has been more prevalent in St. George's, Hanover Square, in November and December than in August, September and October, the months when it is normally prevalent, the average number of cases per month for November and December having been 7·2, and for August, September and October only 4·2. This excess of typhoid fever in November and December was coincident, he said, with the increase in organic matter in the water supplied by the Thames companies when the river was in flood. He pointed out that Mr. Shirley Murphy, the Medical Officer of Health of the London County Council, had drawn attention to the fact that in 1894 there was an excess of typhoid fever in November and December in the London districts supplied by all the water companies, except the East London and the Kent companies, and that this followed exceptional floods in the rivers Thames and Lea. Dr. Corfield stated that he was satisfied from these facts that the distribution of inefficiently filtered river water during November and December was the cause of the increase in the number of typhoid fever cases which occurred among persons especially liable to the disease.

Among the cases of polluted well water described by him, perhaps the most interesting and remarkable was one which he had recently investigated at a country house where there had been a case of typhoid fever, and where, by a peculiar arrangement of the suction pipes of a pump, water was, in certain circumstances, siphoned automatically from a pond polluted with the house sewage into the well supplying drinking water.

Dr. Corfield then described a number of outbreaks in which the poison of typhoid fever had been distributed by means of milk, oysters, cockles and mussels, ice-creams, ginger-beer, and even oranges and grapes, these fruits having been thrown, because they were decaying, into an ash-pit where typhoid excreta had been previously put, and having been picked up and eaten by a number of children.

Among the reports quoted were some from Belgium, France and Germany, kindly sent him by Dr. Kuborn, of Seraing-Liége, Dr. Brouardel, of Paris, and Dr. Pistor, of Berlin, respectively, and also some from different parts of the United States, and others by Dr. J. Ashburton Thompson, the President of the Board of Health of New South Wales.

In concluding his account of the communication of the disease

by foods, Dr. Corfield stated that in 1871 he was called on to inspect the house at which His Majesty (then Prince of Wales) was supposed to have contracted typhoid fever, and reported the results of his investigations in a letter which appeared in the *Times* of January 22, 1872, in which he showed that, although there were certain sanitary defects in the house in question, there were no such defects as had been previously described. For instance, it had been said that the water-closet in their Royal Highnesses suite of apartments was directly connected with a cesspool beneath them, and that its soil-pipe was not ventilated. Neither of these statements was true; there was no cesspool under the water-closet at all, nor, indeed, anywhere on the premises, and the soil-pipe was fully ventilated. There was, in fact, nothing the matter with that water-closet, and it is certain that His Royal Highness did not get his attack of fever from any foul air in it. There was, however, a defect in a water-closet in the middle of the house, and he was unable to say positively that the outbreak of the disease was not due to defective sanitary arrangements. On looking through his notes, made some thirty years ago, he had come to the conclusion that, although it was proved that the outbreak was not caused by water or milk, it was in all probability caused by some other food (such as oysters or salad) which was partaken of by His Royal Highness, the other gentlemen of the party and some of the menservants (among whom all the cases occurred), perhaps at a shooting luncheon, but not by the Princess of Wales, or by any of the other ladies or female servants. Had the outbreak been caused by the insanitary condition of the premises, it would certainly have attacked some of those who were most in the house, whereas it attacked those who were most out of doors and some of those who did not sleep in the house at all.

He then described cases in which the disease had been distributed by means of sewer air and by the washing and mangling of clothes. The questions of ground water and of direct infection were also considered. An account was given of the behaviour of the typhoid bacillus in various circumstances, and the lecture concluded with a reference to the prevalence of typhoid fever in South Africa and its probable dissemination by means of dust and flies, as well as by water, and with some tables of statistics showing the great diminution of the death-rate from the disease in England and Wales, and also in Paris, during recent years. The increase of the disease in Paris during the years 1899–1900 was not peculiar to that city, as it was shared by London and England generally, and it was only heard of because the Paris Exhibition was held in 1900.

EVOLUTION AND ITS TEACHING.[1]

EVER since the dawn of the human intellect, man has tried to increase his knowledge in two ways, by observation and by speculation. Observation came first, for that is common to man and animals. Speculation is a distinctly human attribute, and we find that it soon out-distanced observation, and formed the basis of the earlier philosophies. But during the last few centuries, the observational method has once more come to the front under the name of science, and its conclusions have not always been in accord with those of the speculative philosophies which preceded it.

The difference between the two methods is that whereas speculation starts a chain of reasoning from one or two propositions which are taken as absolutely true, science reasons from the basis of as large a number of observations as possible, and tries to find a hypothesis which connects them all together; or explains them, as it is usually called.

An Outline of Evolution.

The idea of evolution originated with the Greeks, but only as a speculation, which led to nothing; and its scientific history may be said to commence in the early part of the last century, when the practically new theory of the origin of species by gradual development was proposed by Lamarck. This theory was at first discredited for lack of evidence; but it was developed and demonstrated by Darwin in the middle of last century. About the same time it was pointed out by Lord Kelvin that not only was the sun cooling, but that all kinds of energy, when converted into heat, lost a portion by radiation into space, and that this process must go on until the whole universe was of a uniform temperature. So that, although the amount of energy in the universe remains unalterable, it will, by redistribution, be brought into the potential state, and thus, when every possible action is counterbalanced by other actions, energy will practically disappear.

From this theory of "dissipation of energy" it follows that as the earth is cooling, life cannot go on for ever; and also that at some former time the earth must have been too hot for the existence of protoplasm. Consequently, life can only have a limited existence on the earth. It must have had a beginning, and must come to an end.

But the inference extended further. Not only living beings, but even the whole solar system must have had a beginning, not indefinitely remote; because most of its members still contain a large amount of their original heat. And if the solar system had a beginning, so also must each star in the heavens have had a beginning; for the very fact that we can see them is a proof that they are radiating out energy. And, it was asked, why should not the whole universe, visible and invisible, have had a common origin and a common beginning in time? This had been the opinion of Immanuel Kant in the middle of the eighteenth century, and although modern astronomy has not altogether confirmed his speculations, it has proposed a hypothesis which is not very dissimilar. This is the "meteoritic hypothesis," and is chiefly the work of Sir Norman Lockyer and Prof. G. H. Darwin. I will give you a short sketch of the views held by the former.[1]

Inorganic Evolution.

The close connection between the orbits of comets and those of meteoritic streams has led to the universally admitted conclusion that comets are neither more nor less than swarms of meteorites. Again, the resemblance between the spectra of comets and those of nebulæ suggests that these also are swarms, or aggregations, of meteorites. And we naturally infer that the stars with similar bright-line spectra must be collections of meteorites. From bright-line stars we pass to those of which the meteoritic origin is no longer to be recognised, all having blended together. Further, it is claimed that by supposing variable and temporary stars to be due to the meeting and entanglement of two meteoritic swarms we get a better explanation of the observed phenomena than any other hypothesis can give.

This meteoritic hypothesis supposes that the present material universe was at one time in a state of "cosmic dust," spread irregularly through space, and moving slowly in many directions. It is the original irregular distribution of the cosmic dust and its irregular movements which are the source of all the energy in the universe. We have specimens of this cosmic dust in the chondroi, or spherules, of which many of the stony meteorites are built up. They are small round bodies of crystallised minerals, varying from microscopic dimensions to the size of a marble. Of course, these chondroi are not the first form in which matter existed. They are evidently due to chemical reactions, and we could frame several different hypotheses as to their origin and history. But these would be speculations which could not, at present, be verified, and so we must content ourselves with the chondroi as the earliest form of matter known to us.

Through the action of gravitation, much of the cosmic dust is supposed to have aggregated into meteorites, the irregular movements of which were, in certain places, reduced to order; and so arose a number of meteoritic streams, or swarms, moving through space. Still, under the force of gravitation, each of these swarms got more and more dense, until, at last, collisions took place between the meteorites; light and heat were given out, and the swarm became a nebula. The heat produced by the collisions would, at first, be slight, but would gradually increase, until the whole of the solid material was resolved into vapour and a star was formed. Concentration, however, would still go on, and the temperature of the star would rise until, in time, the loss by radiation more than counterbalanced the gain by concentration, when the star would begin to cool. At last light would no longer be given off, and the star would end by becoming a dark cold body moving in space. Of course, some stars would attain a higher maximum temperature than others, and either a single or a double star might be the result of the condensation; but all would follow a somewhat similar development.

[1] Abridged from an inaugural address, delivered before the Australasian Association for the Advancement of Science, by Captain F. W. Hutton, F.R.S., president, on January 8.

[1] See "The Meteoritic Hypothesis" (Macmillan, 1890); and "Inorganic Evolution" (Macmillan, 1900).

Now, as a matter of fact, the spectroscope shows us that stars in all these stages actually exist at the present day in the heavens. In some the temperature is increasing, in others it is decreasing, and, although small stars must run through their development quicker than large ones, this is quite insufficient to account for all the present differences. From which it follows that some of the stars are much older than others. The sun was amongst the earliest of formed stars. When it was born, the sky must have presented an almost uniform blackness. There was no Milky-Way; no Orion or Southern Cross; no Pleiades or Dog Star. All these, and many others, have been added since; not altogether, but one after the other, through the long ages during which the sun was undergoing development. Judging by the relative ages of the stars, it seems probable that the process of concentration of the original cosmic dust commenced near the solar system and spread outwards to the Milky-Way. But, however this may be, the process is not yet over. Many nebulæ have not yet condensed into stars. Swarms of meteorites still traverse space, and, even in the neighbourhood of the solar system, they are so abundant that the earth alone is estimated to collect more than twenty millions each day.

However, slow as the process of condensation is, it is not endless. In time all the meteoritic dust will be collected into stars or planets, and in time the law of dissipation of energy will bring all these bodies to a uniform temperature. So at last the movements due to the original unequal distribution of matter will cease and the life of the universe will come to an end. We know of no process of rejuvenescence by means of which dissipation of energy, and the force of gravitation, might be counteracted. Several attempts have been made to refute the theory of dissipation of energy, but all have failed. The ether which pervades space is the only part of the universe which shows no sign of evolution. It alone remains unchanged.

A casual glance at the stars gives us the impression of immutability. We still speak of the fixed stars in much the same way as our forefathers used to speak of the everlasting hills. But we know that they are not fixed. We know that the nearer stars, including the sun itself, are in swift movement; and we infer that all are so. But we can see no connection between their movements. Single stars, or small groups of stars, are rushing through space in various directions, and we cannot detect any common centre of gravity which holds them in control. The stars have not yet attained the regularity of movement that gravitation must bring about in a very ancient system, and this idea of the comparative youth of the universe is strengthened when we remember that large numbers of the primitive meteorites are still wandering in space uncondensed into stars. If it be true that the sun is one of the oldest stars in the universe, and if, as geologists think, the earth is not more than a hundred millions of years old, then it may very well be that the creation of the cosmic dust out of which the stellar universe has been formed took place less than two hundred millions of years ago. But although it may be possible to place a limit to the age of the universe, we can fix no time for its duration. It is impossible to form an estimate of the hundreds of millions of years that will pass before the end approaches. Still, a time must come when all energy will be equilibrated, and when, possibly, the visible universe may resolve itself into invisible, motionless ether.

In the solar system we can study the development of a meteoritic swarm in greater detail. Here we find that the whole of the meteorites did not collect into a single mass, but that several planets, as well as the sun, were formed simultaneously. It has been shown by Prof. G. H. Darwin that the effect of many collisions among a swarm of meteorites would be gradually to eliminate orbits of great eccentricity until, in time, a regular system would be developed, when the whole of the meteorites would travel nearly in the mean plane of their aggregate motions. The larger of the meteorites would tend to settle towards the centre, while other aggregations might easily occur at different distances from the centre. And of these the outer planets would be larger than the inner ones, because in the more distant regions, where the attraction of the central sun was less, the movements of the meteorites would be slower, and there would be a greater tendency to agglomeration than where the movements were more rapid. As meteorites contain but little oxygen, hydrogen, carbon, silicon and alkalis—substances which are all abundant on the surface of the earth—large numbers must have been fused together to form the earth, and the lighter substances must have collected near the surface. Consequently, the collisions between these meteorites must have occurred with sufficient rapidity to melt the whole mass. For after a solid crust had been formed, all the meteorites which fell on the earth would remain on the surface as they do now.

As with the solar system, so, also, in the earth itself we can trace distinctly a physical evolution. The discovery of tidal friction gave an independent proof that the earth had had a beginning not infinitely remote, for if that had been the case, the tidal friction would have reduced the time of the earth's rotation on its axis to that of the moon. Also we have sufficient geological evidence to show that not more than one hundred millions of years ago the earth was in a molten condition, and, probably, shone with its own light. As cooling went on, the silicates crystallised out, forming a solid crust over the still molten, metallic interior, the earth then becoming a dark body. At that time all the water above the crust was in a state of vapour which, subsequently, fell as hot rain, forming a boiling ocean. With this rain the denudation of the primitive crystalline rocks commenced, and their débris was deposited on the bed of the ocean as sedimentary rocks. Gradually the continents were formed, the new ranges of mountains following each other in orderly succession, the great oceans becoming narrower and deeper as well as more and more salt. These processes are still going on, but, as the earth is cooling, the internal energy which uplifts the mountains must be diminishing, and in time it will be insufficient to counteract the denudation. Then the whole of the land will be swept into the sea, and the waves of the ocean will roll over the surface of the earth unopposed; unless, indeed, before that time arrives the ocean should have been frozen into a mass of ice, or should have sunk slowly into the ground. All these things are approaching, but which of them will come first it is impossible to say.

Organic Evolution.

When, during the course of physical evolution, the ocean had become sufficiently cool for the existence of protoplasm, minute living organisms appeared on its surface. These increased in size, varied in many directions, and, in time, discovered the bottom of the sea, on which they established themselves, changing from swimming to crawling creatures. Gradually these organisms managed to live in safety among the rough waters of the sea coast, and then they spread over the land, first the plants and then the animals, which came to feed on the plants.

Once established on land and breathing air, improvements in the circulatory system of the higher animals became possible. The purified blood was kept separate from the impure blood, and increased rapidity of physiological processes heated the body, so that, in the birds and mammals, a stream of pure, warm blood was poured upon the brain. Thus stimulated, the brain developed rapidly, and the psychological evolution, thus inaugurated, has reached such a height in man as to place him mentally apart from the rest of the animal kingdom.

Biological evolution differs from physical evolution in being brought about by the transmission of bodily variations from one generation to another. And in psychological evolution, mind is transmitted from parent to offspring, as well as the organ in which it is to be manifested. Intelligence, however, depends, not only on the structure of this organ, but on early associations and education, by which means the wisdom of one generation is handed down to the next.

Psychological evolution consists of two parts. The first is intellectual, and is found in all the higher animals as well as in man. The second is ethical, and is exclusively human.

Intellectual evolution, like biological evolution, is due to competition between different individuals and the action of selection. We probably see the first germs of ethical evolution in parental affection, which, among gregarious animals of sufficient intelligence, widened into social sympathy, and this, in man, gave rise to the social or civic virtues.

This advance also appears to have been, or, at any rate, may have been, due to selection, and the result was the emergence of what is called utilitarian morality. Morality, in the strict sense of the term—that is, formal morality—also appears to have arisen from sympathy, but not by means of selection. The long and constant use by man of formal morality has made it instinctive, and has thus given rise to the conscience.

Secondary Causes.

When we think of the whole work that has been accomplished by evolution we are overwhelmed by its vastness. The results of organic evolution, particularly, are so marvellous that, to our

limited intelligence, the forces to which they are due seem to have been constantly directed in their course. The human mind is more disposed to accept the idea of guidance than that of predetermination, as it seems to us to be the less impossible of the two, and the more easy to understand. We ourselves wait upon circumstances; we see how things are going to shape before we move, and we fancy that the world must have been made, and must be carried on, on the same principle. But the study of nature gradually causes this belief to fade away. The more we learn the more we see that secondary law extends much further than we had expected, and we begin to think that all may be due to secondary laws.

We cannot doubt but that the most complicated cases of inheritance—such as the growth of the train feathers of a peacock, or the gorgeous wings of a butterfly—are due to secondary laws, although the processes are quite incomprehensible to us. We believe these to be due to secondary laws, because we see them taking place in exactly the same order over and over again; and in the case of the peacock we know that if we pull out the feathers, new ones, similar to the old, will replace them. So that we can bring these laws into play whenever we choose. It is not sufficient, therefore, to say that an action is not due to secondary law, because it is so wonderfully intricate, or because it is incomprehensible to us. We must be able to show, either that the action is antagonistic to known natural laws, or that the result could not be due to a combination of any natural laws that we have already discovered. That is, we must show a discontinuity in the phenomena. Can any such breaks be discovered?

The origin of the material universe, which was the starting point of the present evolutionary process, appears to us to have been a new departure in natural law. But we cannot feel certain about it, for we do not know, and never can know, what went before. But with the origin of life on the earth it is different. The intimate structure of organic beings, as well as their order of development on the earth, point to the conclusion that they are all derived from a common ancestor, and that living protoplasm was formed once, and once only, on the surface of the sea. Now, in the origin of living substance on this planet we have a case which is generally recognised as a break in continuity. It is generally allowed that it was an action which is not only incomprehensible by us, but one which conflicts with our knowledge of natural laws. That an unstable chemical compound, endowed with the power of directing energy independently of any outside agent, should have been brought into existence by the action of known physical laws is an impossibility. The processes of assimilation and fission, on which all progress depends, are quite distinct from anything which had gone before. And as every living cell is imbued with what we call instinct, which directs its energies, it follows that in physiology action and reaction are not equal and opposite. Indeed, every organism inherits from its parents a store of energy which directs growth and which appears to be inexhaustible. It is drawn upon during the whole period of growth, which, in some plants, lasts all through life, and yet abundance is left for transmission to its offspring, no matter how numerous they may be. The store increases instead of diminishes, and we cannot tell why. Until some explanation can be given, it is not only permissible, but reasonable, to view the origin of life as due to some guiding action of natural law, especially when we remember what that break in continuity has led to.

Again, it has been often pointed out that the genesis of consciousness is as great a mystery as the genesis of life, and that it seems to be equally opposed to the law of conservation of energy. In the lower animals, and in some of the lowest plants, we see physiological processes producing movements which appear to be intelligent, but which, in reality, are no more so than the movements of the leaves of a sensitive plant. And it is generally allowed that for the exhibition of consciousness a brain-cortex is required; but how matter in the brain-cortex becomes self-conscious we cannot understand. However, it is possible to suppose that mind is a necessary concomitant of life, so that the origin of the two may be one and the same problem. Also, as consciousness may be lost—as in habit—and regained by attention, it is possible that consciousness may be a constant function of mind, but one that cannot become efficient until a large number of specially formed cells are accumulated in a brain-cortex. I cannot, therefore, see that the genesis of consciousness in animals necessarily marks a break in continuity, notwithstanding that its origin is quite incomprehensible to us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Proposals have been laid before the Senate for modifying the principles of classification in the natural sciences tripos, though the proposals are not unanimously acquiesced in by the boards concerned. In part i., in which at present the aggregate mark in three or four sciences governs the class, it is suggested that weight should also be given to the candidate's particular performances in each subject. In part ii., a candidate is required, for a first class, to take at least one primary and one subsidiary subject; it is proposed to abolish the requirement of a subsidiary subject. It is further proposed that human anatomy and vertebrate comparative anatomy should in future be reckoned as a single subject in this part of the tripos. These changes, if approved, are to come into effect in 1904.

Earl Spencer, K.G., has been appointed an elector to the professorship of agriculture in the place of the late Sir J. H. Gilbert, F.R.S.

UNDER the will of the late Dr. Nathaniel Rogers, the Senate of the University of London offer a prize of 100*l.*, open for competition to all the members of the medical profession in the United Kingdom, for an essay on "The Production of Immunity in Specific Infective Diseases—generally, and with particular Reference to any one Disease on which the Writer of the Essay may have made Original Investigations." Essays must be sent in not later than February 28, 1903, addressed to Mr. Percy Wallace, secretary to the Senate.

THE report of the executive committee of the Carnegie Trust for the Universities of Scotland on the administration of the trust for the period from June 7, 1901, to December 31, 1901, was read and passed at a meeting of the trustees last week. For the winter session 1901–2, the sum of 22,941*l.* 16*s.* 6*d.* was paid by the trust up till December 31, 1901, on behalf of 2441 students, representing the fees of 7610 classes. The committee, in accordance with the expressed desire of Mr. Carnegie, did not make question respecting the circumstances of applicants; but from information voluntarily offered by applicants themselves, they have ample assurance that in a large number of cases the payment of class fees has proved a boon of the greatest value to deserving students, and many acknowledgments of the letter sent to the parents and guardians of applicants express gratitude for the timely assistance rendered by the Trust. The class fees paid and the number of students were as follows:—St. Andrews, 268 students, class fees, 2452*l.* 16*s.*; Glasgow, 828 students, class fees, 7672*l.* 13*s.* 6*d.*; Aberdeen, 473 students, class fees, 3806*l.* 1*s.* 6*d.*; Edinburgh, 872 students, class fees, 9010*l.* 5*s.* 6*d.*

MR. J. H. GARTSIDE has given to the Owens College, Manchester, the sum of 10,000*l.*, which has been applied in the purchase of an annuity of 1163*l.* a year for ten years, payable to the college, to be used for the provision of scholarships, which are to be known as "The Gartside Scholarships of Commerce and Industries." The scholarships are intended to induce young men who have already received a good education to devote a year at least in Owens College to the special study of subjects bearing on commerce and industry, and then to go abroad for the study of some particular subject, either in Germany or the United States, or some other country approved by the electors to the scholarships. The emoluments of the scholar while in England will be about 80*l.* a year, but when travelling abroad a larger sum will be given, which in the case of scholars travelling in the United States will probably be about 250*l.* per annum. The scholars are to furnish reports of their investigations in the foreign countries which they visit. These scholarships are intended by Mr. Gartside to be an incentive and assistance to those who contemplate a careful study of commercial and industrial methods, and should enable useful information to be obtained with regard to these subjects, both in America and on the Continent.

AT the annual general meeting of the members of University College, London, held last week, Lord Reay moved the following resolution on behalf of the council:—"That this meeting has heard with great satisfaction of the generous offer of the Drapers' Company to make themselves responsible for the debt upon the college to the extent of 30,000*l.*, and of another friend

of the college to give an equal sum, conditionally upon the college being incorporated in the University of London, and concurs in the resolution of the council to enter into negotiation with the University with a view to the incorporation." He said the idea of incorporation was not a new one, because when the statutory commissioners were sitting for the purpose of framing the statutes for the reconstitution of the University of London, the council represented to them the intention of the founders and benefactors of University College would only be carried out by incorporation. The commissioners, however, felt that the terms of the Act did not make it possible for them to give effect to the proposal. The council had not abandoned the policy, and since the beginning of the present year events had taken place that brought it within the range of speedy realisation. With regard to the appeal for funds, it was quite obvious that if the work which was being carried out was to be continued, the funds would need a much larger increase. Lord Monkswell, who seconded the resolution, hoped there would be many rich men who would follow the example of their anonymous benefactor. He trusted that the negotiations which they were having with the University of London would be successful, and said that no conciliatory efforts on their part would be wanting. The resolution was adopted.

THE address delivered before the Association of Technical Institutions on January 31, by the president, Lord Avebury, is published in the official report of the proceedings of the meeting. The address was, in a large part, a plea for more liberal recognition of science and modern languages in the time-tables of our schools, supported by the opinions of commissions and other competent authorities. Classics has at present too large a portion of the available time, and science is only tolerated. "An education which excludes science is a one-sided education, and the most learned classical scholar, if he knows nothing of science, is but a half-educated person after all." But the question is not so much one of culture as of equipment for national progress. When, as Lord Avebury remarks, we find commission after commission (composed of men selected for their wisdom and experience), after careful and patient inquiry, one after the other, and with remarkable unanimity, pointing to the neglect of science and of modern languages in our educational system as a grave evil, it must surely be worth while to inquire whether these warnings have been taken to heart, or the recommendations have been carried into effect. Lord Avebury gives instances, most of which are known to readers of NATURE, of industrial progress in Germany due to technical training. "It is evident then," he concludes, "that the technical instruction of Germany has been a very remunerative investment; in the first instance, no doubt, a great national advantage, but a boon also to the world as a whole. These figures bring home to us clearly the importance of the subject. It is obvious how keen competition is going to be. If we are to hold our own, we must supplement the rule of thumb in our workshops—very important in itself—by the rule of brain. Emerson once said that this country 'is prosperous because steam is half an Englishman.' We all hope that Britannia may long rule the waves, but it is most important that she should rule the steam engine and the dynamo as well."

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxiv. No. 1, January.—Cyclic subgroups of the simple ternary linear fractional group in a Galois field, by L. E. Dickson. This paper is an addition to the author's previous one in vol. xxii. pp. 231–252. It gives proofs of results therein stated and adds some new theorems allied to them. The question discussed concerns the substitutions

$$x^1 = \alpha^r x,\ y^1 = \alpha^t y,\ z^1 = \alpha^{-r-s} z,$$

where α is a primitive root of the Galois field of order p^m. Two cases arise according to the value of the greatest common divisor d of 3 and $p^m - 1$.—Curves of triple curvature, by J. G. Hardy. The object of the paper is to add to the results which have been obtained concerning curves L of triple curvature. Equations of motion for systems in a four-dimensional space have been deduced and used to introduce the notion of an instantaneous plane of rotation. The derivation is not new, but it is retained for the sake of clearness. By constructing the principal tetrahedroid at a point of a curve of triple curvature and studying its motion by means of the kinematical equations obtained, geometrical interpretations of the six rotations and also a set of formulæ corresponding to the Serret-Frenet formulæ for curves of double curvature have been arrived at. These formulæ have been applied to the study of curves L and, in particular, of the osculating hypersphere and the locus of its centres. Many of the results were contained in a paper read before the mathematical seminary of the Johns Hopkins University in 1898, and so were antecedent to the articles by Prof. Lovett and Mr. Hatzidakis in vol. xxii. The subject may be studied in Brunel, *Math. Ann.* xix. p. 48; Pirondini, *Giom. di Mat.* xxviii. p. 237; and Piccioli, *Giom. di Mat.* xxxvi. p. 273.—Primary prime functions in several variables, and a generalisation of an important theorem of Dedekind, by H. Hancock. Reference is made to Kronecker, "Grundzüge," &c., § 4, p. 11; Runge, *Crelle*, Bd. xcix. p. 89; Mandl, *Crelle*, cxiii. p. 252; Meyer, *Math. Ann.* Bd. xxx. p. 30, and to other memoirs.—On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts. In this second part, which is on certain plane cubic curves and their angles of intersection, with some account of conics cutting orthogonally, the author investigates some methods of generating certain plane cubic curves in such a way that their angles of intersection assume a simple form.—Estimate of Peirce's linear associative algebra, by H. E. Hawkes. In the fourth volume of the *Journal* there appeared a memoir by Peirce in which he attempted to classify and enumerate hyper-complex number-systems. This does not seem to have received on the Continent the credit it deserves. In order that it should receive due recognition, Mr. Hawkes claims that three questions must be discussed, viz., what problem did Peirce attack, and to what extent did he solve it? what relation does this problem bear to that treated by Study and Scheffers? and to what extent do Peirce's methods assist in the solution of that problem? In the present article, Mr. Hawkes discusses the first two questions, and discusses the last in the *Transactions* of the American Mathematical Society, vol. iii. A historical review accompanies the article. It may be remembered that Mr. Spottiswoode drew attention to Peirce's work in his presidential address before the London Mathematical Society (vol. iv. p. 152); see also Cayley, "Collected Works," xi. p. 465; xii. p. 465.—Dr. G. A. Miller furnishes a short note on groups defined by the orders of two generators and the order of their product.—A fine portrait of Prof. Benjamin Peirce is given with the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1901.—"The Effective Temperature of the Sun." By W. E. Wilson, D.Sc., F.R.S.

In a memoir by the author and Mr. P. L. Gray, entitled "Experimental Investigations on the Effective Temperature of the Sun," published in the *Phil. Trans.* Roy. Soc. A. vol. clxxxv. (1894), the method described was as follows:—A beam of sunlight reflected from a Stoney single-mirror heliostat was directed into one aperture of a Boys' differential radio-micrometer. The other aperture received the radiation from a small circular area of a strip of platinum raised to any desired temperature by an electric current, this temperature being measured by the linear expansion of the platinum as in Joly's meldometer. Knowing then the ratio of angular diameter of radiating area of platinum to that of sun, the temperature of the platinum strip, the emissivity of bright platinum, and the amount of the sun's radiation lost by absorption in the earth's atmosphere and by reflection from the heliostat mirror, it is possible in any assumption of a law connecting radiation with temperature to determine the effective solar temperature. The mean of a series of very accordant observations gave 6200° C. (absolute).

To protect the incandescent strip from draughts of air it was covered with a water-jacket of gilded brass. Possibly some of the radiation from distant parts of the strip may have been reflected between the polished walls and the strip itself and, ultimately escaping through the circular aperture fronting the radio-micrometer, reached it and so vitiated the result. Smoking the interior of the water-jacket sensibly reduced the amount of radiation and so proved this surmise correct.

It is also possible that changes in the surface condition of the platinum may effect its emissivity, which in the original memoir was taken at 0·35 that of lamp-black (Rosetti's estimate), so that it is a distinct advantage to abolish the platinum strip as a source of radiation and to substitute a uniformly heated enclosure which would radiate as an absolutely black body.

In 1895 Mr. Lanchester pointed out to the author that such an enclosure would be a theoretically perfect radiator; while Lummer, Paschen and others using radiation from such a source have confirmed in a remarkable manner Stefan's law of radiation, viz. $R = aT^4$.

The radiator employed was a porcelain[1] tube 2 feet long and 1 inch internal diameter fitted into a Fletcher gas-tube furnace. A plug of asbestos was inserted in the tube about 10 inches from the end remote from the radio-micrometer, and resting against this plug was the end of a Callendar platinum resistance thermometer. In front of the open end of the tube was a rectangular aperture 5 mm. wide in a large brass water-screen; a slide closing this aperture was moved by a micrometer screw reading to 0·01 mm. This aperture was 66·3 mm. from the surface of the thermocouple (Fig. 1).

To make an observation, the tube was heated to as high a temperature as the furnace was capable of, and the radiation from the interior of the tube passing into the aperture (B) of the radio-micrometer was adjusted by the micrometer screw until a balance was obtained with the radiation of the sun through the aperture (A).

After a series of observations had been made, the arrangement was altered so that the radiation from the tube should enter aperture (A) and from the sun aperture (B) of the radio-micrometer, and in this position a second series of observations was taken. The geometric mean of the results of the two groups gives the effective temperature of the sun.

The mean of the observations thus made gave 5773° C. (absolute) as the sun's effective temperature.

In calculating this result, Rosetti's coefficient of atmospheric absorption, viz. 0·29, has been used. Taking Langley's value, viz. 0·41, the result will be 6085° C. (absolute).

It is interesting to allow for the effect of absorption in the sun's atmosphere. Assuming the results of Wilson and Rambaut's experiments (*Proceedings* Royal Irish Academy, 1892, vol. ii. No. 2), the value 6863° C. (absolute) is deduced as the effective temperature of the sun's photosphere.

Physical Society, February 28.—Prof. S. P. Thompson, president, in the chair.—A paper on focal lines and anchor-ring wave-fronts was read by Prof. J. D. Everett. When a small cone of rays is obliquely incident on a spherical reflecting or refracting surface, the rays after reflection or refraction no longer compose a true cone. Instead of meeting in a point they form a narrow neck, and this neck is flattened in two places called the *two focal points*, the planes of flattening being at right angles to each other. Optical writers give the name *focal lines* to the sections of the pencil made at the focal points by planes perpendicular to the axis of the pencil; but it would be more appropriate to give the name to the sections which most nearly resemble lines, whatever angle they make with the axis of the pencil. Attention is drawn in the present paper to the case in which the wave-front in one of its positions is a tore (or anchor-ring). Even when dealing with wide-angled pencils there are then two well-defined focal lines, the primary focal line being what may be called the circular axis of the tore, and the secondary a portion of the line about which the generating circle turns to form the anchor-ring. Toric wave-fronts can be produced by reflection from a mirror made by allowing an ellipse or portion of an ellipse to revolve completely round an ordinate erected at one focus, and employing it to reflect rays diverging from a small source at the other focus. The primary line is always real; the secondary is real or virtual according to the position of the area of incidence of the pencil.—A paper entitled "Contributions to the Theory of the Resolving Power of Objectives" was read by Prof. Everett. The practical limit to the resolving power of objectives depends upon the blurring due to diffraction. Observations on double stars for the purpose of investigating the separating power of telescopes have been made by Dawes, who arrived at the conclusion that the angular distance between the two components, when they are nearly equal in magnitude and are just separated, is given by the formula, 4·56 seconds divided by the diameter of the objective in inches. Foucault also investigated the matter experimentally, and in 1830 Airy calculated the brightness at various points of the spot and rings which constitute the image of a point source formed by an objective. If the extreme difference of optical path for disturbances coming from different points of a concave wave-front to a point at lateral distance b from the geometric focus is made equal to the wave-length of light, a value for b is obtained which represents with fair accuracy the limit of separation as determined by experiment. The formula agrees with that of Dawes if $\lambda = .56$ micron., whereas the wave-length of the brightest ray is usually taken as ·55 micron. In the case of microscopes the author has supposed that the formula for the minimum distance b still holds good, and combining this equation with the sine condition applicable to optical systems giving sharp flat images, he has deduced the expression which has been extensively used

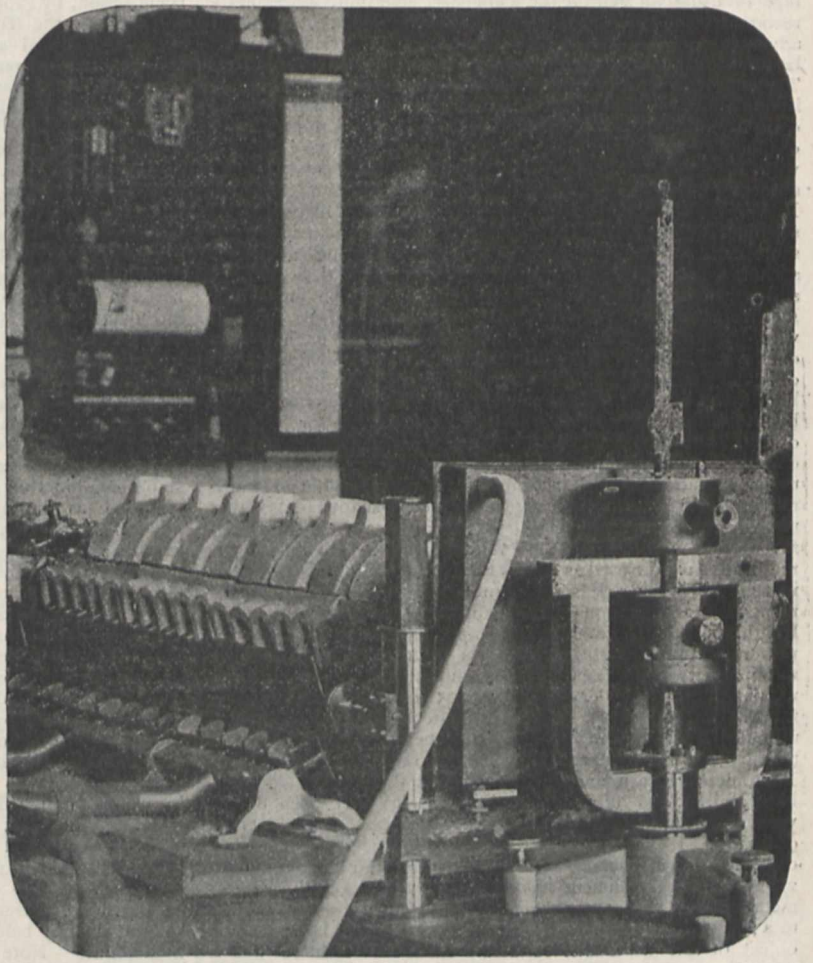

FIG. 1.—Differential radio-micrometer with tube furnace.

[1] In later experiments an iron tube was substituted.

for the distance between lines or points which can be barely separated. Microscopic test objects are not self-luminous, like double stars, but are viewed by transmitted light. If no condensing arrangement is employed, the pencil of light sent by a point of the object to the objective consists, in effect, of rays from different sources. The result of this is that the image of the point is larger and more blurred. The cure for this evil is furnished by employing a condenser of high quality, to throw upon the part of the object under examination a very sharp image of the source of illumination. Each point of the object thus gets its light from its own special point of the source; the object, therefore, acts as if it were self-luminous, and the power of the instrument is increased. The benefit derived from sharp focussing on the object explains the advantage of using an achromatic condenser and not, as formerly recommended by Abbe, one which is not achromatic. Another advantage of sharp focussing by the condenser is that there can be no interference of the light from different parts of the object. The author then gives an explanation of the advantage of oblique illumination, and arrives at the view of microscopists that the obliquity of illumination should be rather less than the obliquity of the extreme rays of the incident pencil. The paper concludes with Hockin's proof of the sine condition.—A paper on the absorption, dispersion and surface colour of selenium, by Prof. R. W. Wood, was read by the secretary. The dispersion of selenium has been investigated by means of prisms made in the same manner as the cyanine prisms already described by the author. The substance is much more transparent than cyanine, and prism angles of four or five degrees can be employed. Determinations were made with three selected prisms down to wave-length 61; below this the interferometer method was employed. Uniform films of selenium were obtained on plates of plane parallel glass by means of a flat selenium kathode in a high vacuum, and the displacements of the interference fringes by the introduction of the films were measured for lights of different known wave-lengths. Wedge-shaped films were then employed, which allowed the displacement for any wave-length to be measured for the maximum thickness capable of transmitting the light. An advantage of the wedge-shaped films is that the fringes are curved and the displaced fringe can be easily identified with the undisplaced. The refractive indices obtained in the red by prisms were used as a basis for the calculation of the indices in the rest of the spectrum from the interferometer measurements. Determinations were made in this way down to wave-length 40, beyond which it was impossible to go owing to the powerful absorption. A curve has been plotted showing the relation between refractive index and wave-length. It has a maximum at wave-length 50 ·00005 cm.), where the refractive index is 3·13. An examination of the light transmitted by a thin film showed that there was no return of transparency in the ultra-violet at least down to wave-length 28. Photometric measurements were made of the transmitted light, both visible and ultra-violet, and a curve has been drawn with wave-lengths as abscissæ and extinction coefficients as ordinates. It is proved that the extinction coefficient increases continuously with decrease in wave-length as far as wave-length 22, where the coefficient has as high a value as in the case of metals. The author concludes that the absorption is due, not to a single band, but to a series of overlapping bands. The object of this work was to determine whether there was a return to partial transparency in the ultra-violet region. This question appears to be answered in the negative, although a possible turning-point in the curve might be masked by the reflection coefficient of selenium. The high value of the extinction coefficient in the ultra-violet led the author to look for traces of selective reflection in this region. The light of an arc lamp was reflected successively from six surfaces of selenium, and the image of the crater after the sixth reflection, although faint, was without colour or excess of ultra-violet light. If the data obtained in the paper for refractive index and extinction are used in the formula for reflection from an absorbing medium, a result is arrived at which indicates that the reflection increases rapidly with decreasing wave-length. As multiple eflections from selenium surfaces give no trace of colour, errors must exist in either the refraction or the extinction curve. The author suggests that in the case of films of thickness less than the wave-length of light, the displacement of the interference fringes does not give a measure of the refractive index.—The chairman exhibited some tellurium mirrors made in the same way as the selenium ones used by Prof. Wood.

Chemical Society, February 19.—Prof. Emerson Reynolds, V.P.R.S., president, in the chair.—The union of hydrogen and oxygen, by Mr. H. B. Baker. The author has devoted, during the last few years, much attention to the inhibition of chemical action produced by thoroughly drying substances, but until quite recently had not succeeded in so completely desiccating a mixture of oxygen and hydrogen as to prevent the explosion of such a mixture when electric sparks were passed through it. He has now found that by electrolysing a solution of barium hydroxide it is possible to obtain a mixture of these gases which, when dried over phosphorus pentoxide, is no longer exploded by electric sparks or by the application of intense heat, the highly explosive character of the mixture, however, being regained by the introduction of a mere trace of moisture.—Enzyme action, by Prof. A. J. Brown. Some years ago the author showed that the fermentation of saccharine solutions by yeast does not proceed according to the ordinary mass law which governs chemical reactions. On the other hand, O'Sullivan and Tompson found that the inversion of cane sugar by the enzyme invertase follows this law. Since both of these reactions, in the light of Buchner's researches on zymase, are produced by enzymes, there appeared to be a remarkable difference in the operation of the latter. The inversion of sucrose by invertase has, therefore, been reinvestigated by the author, who finds that this reaction does not progress according to the mass law, but in precisely the same way as the fermentation of sugars by yeast. The explanation of this feature of enzyme action is, the author thinks, the formation of an intermediate unstable compound between the enzyme and the substance it is decomposing, thus introducing a time factor which obscures the mass influence.—On the velocity of hydrolysis of starch by diastase, with some remarks on enzyme action, by Mr. H. T. Brown, F.R.S., and Mr. T. A. Glendinning. The authors confirm the results obtained by Prof. Adrian Brown with regard to the progression of hydrolytic reactions caused by enzymes, but they explain the peculiarity exhibited in a different manner, an attempt being made to connect enzyme hydrolysis with acid hydrolysis, the unstable combination of starch or sugar with the enzyme being regarded as the hydrolyte and the active dissociated water molecules present as the hydrolysts.—Polymerisation products from diazoacetic ester, by Dr. O. Silberrad. Three series of polymerides are obtainable from diazoacetic ester, and the present paper gives an account of the results of experiments on the so-called "pseudo-diazoacetamide," whereby the author has been able to assign a constitution to this substance.—Condensation of phenols with esters of unsaturated acids, by Dr. S. Ruhemann. The author describes the products obtained by the action of ethyl chlorofumarate on guaiacol and α-naphthol, whereby a benzopyrone and a naphtharone are respectively formed.—The chemical change produced by the immersion of lead in distilled water, by Dr. F. Clowes. Distilled water, recently boiled, exerts very little action upon metallic lead immersed in it, but unboiled distilled water converts the metal into hydroxide of lead, which remains in solution, and into a hydrated carbonate, which is precipitated. The principal agent in effecting this change appears to be the oxygen dissolved in the water.—The bases contained in Scottish shale oil, part i., by Messrs. F. C. Garrett and J. A. Smythe. The fraction of Broxburn shale oil boiling below 164° contains pyridine and several of its homologues.—Note on liquid nitrogen peroxide as a solvent, by Prof. P. F. Frankland, F.R.S., and Dr. R. C. Farmer. The authors note that in their recent paper on this subject they inadvertently omitted any reference to the previous work by Bruni and Berti, who investigated the cryoscopy of nitrogen peroxide solutions of various substances and pointed out the associating power of this solvent.

Linnean Society, February 6.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. Reynolds Green, F.R.S., exhibited some primroses which showed the rare phenomenon of sepalody. The corolla was green and the limbs of the petals were rugose and of a texture almost comparable with that of the foliage-leaves. He also showed another specimen in which the calyx as well as the corolla was petaloid. Both specimens were received from a garden in the north of England.—Messrs. H. and J. Groves exhibited a series of British hybrid batrachian Ranunculi, together with specimens of their supposed parents. They pointed out that the hybrids were usually characterised by (1) being intermediate in appearance between the two parents, having some of the distinctive characters of each, but with a

more vigorous vegetative growth, and (2) by the fruit being mostly abortive and the peduncles not becoming recurved.—Mr. Francis Darwin, F.R.S., read a paper on a method of investigating the gravitational sensitiveness of the root-tip, showing the apparatus used and lantern-slides of seedlings under experiment. Confining himself to the modern development of the question, the author remarked that the observations of Czapek and of Pfeffer having been contradicted by Wachtel, it had become desirable to confirm these observations by employing a different method. The apparatus used consisted of a counterbalanced lever 53 cm. long, able to turn in any direction by being mounted on knife-edges. Seedlings of the bean and the pea were employed, and glass tubes, straws and dandelion scape were in turn used to contain the root-tip, and, by the aid of certain mechanical appliances, to prevent the root slipping out of the tube. The tip being fixed, the remaining part of the root and the hypocotyl became curved in varying degrees, due to the continued stimulation of the root-tip. The result has been confirmation of the observations made both by Czapek and by Pfeffer.—Dr. D. H. Scott, F.R.S., gave an account (illustrated by lantern-slides) of an extinct family of ferns—the Botryopterideæ, our knowledge of which is primarily due to the researches of M. Renault.

Zoological Society, February 18.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Mr. W. B. Tegetmeier exhibited and made remarks upon the skull of a supposed hybrid between the sheep and the pig, named "cuino" by the inhabitants of Mexico, where it is stated to be extensively reared as an agricultural animal. The skull was clearly that of a pig.—Dr. C. I. Forsyth Major exhibited and made remarks upon some remains of voles from the Upper Val d'Arno (Italy) and from the Norwich Crag, representing *Microtus pliocaenicus* (Maj.) and *Microtus intermedius* (Newt.). Dr. Forsyth Major considered that they belonged to a distinct genus, which he proposed to name Mimomys.—Mr. R. Lydekker exhibited, on behalf of Mr. Rowland Ward, two pairs of antlers and a skull of an elk from Siberia (beyond the Altai). Mr. Lydekker pointed out that, although belonging to adult animals (as the dentition of the skull indicated), the antlers had practically no palmation—a characteristic which induced him to propose the specific name *Alces bedfordiae* for the Siberian elk.—Dr. C. I. Forsyth Major gave a description of *Mustela palaeattica*, Weith., from the Upper Miocene of Pikermi and Samos, based chiefly on an almost perfect skull from Pikermi in the Turin Museum.—Mr. Oldfield Thomas, F.R.S., read a description of two new rodents discovered by Mr. P. O. Simons near Potosi, Bolivia. The one proposed to be called *Neoctodon simonsi* was allied to Octodon, but had simpler teeth, without enamel infoldings, and a bushy tail, the size and external appearance being much those of *Neotoma cinerea*. The second, called *Andinomys edax*, was allied to Phyllotis, but had much larger, more complicated and highly hypsodont teeth; in general appearance it was like a large Phyllotis, such as *Ph. darwini*. Its head and body measured 160 mm. and its tail 145 mm.—Mr. Oldfield Thomas also read a paper on some new mammals from northern Nyasaland, which had been contributed to the National Museum by Commissioner Alfred Sharpe, C.B., and Colonel Manning.—Mr. Boulenger, F.R.S., made remarks on the characters of the very young form of Polypterus, connecting the early stage recently discovered by Mr. Budgett with the more advanced stages described by Dr. Steindachner and himself. Characters were pointed out by which the young of *Polypteri lapradii*, *congicus*, *endlicheri*, *weeksii*, *senegalus* and *palmas* could be distinguished. Special attention was drawn to young specimens of *P. lapradii* from Nigeria, in which the external gills measured up to one-third of the total length.—Mr. Boulenger also drew attention to a new snake of the genus Psammophis, from Cape Colony, of which a specimen had been presented to the British Museum by Dr. G. Leighton. The name *P. leightoni* was proposed for this new species.—Mr. F. E. Beddard, F.R.S., read a paper dealing with the tuft of vibrissæ commonly met with upon the wrist of mammals belonging to the orders Lemuroidea, Carnivora, Rodentia and Marsupialia. It was pointed out that this structure was found in both sexes and in a large proportion of the genera and species belonging to the mammalian groups mentioned. As to other orders of mammals, the only ungulate in which they had been discovered was stated to be Hyrax; of edentates, the armadillos alone possessed these vibrissæ upon the wrist.

CAMBRIDGE.

Philosophical Society, February 17.—Prof. Macalister, president, in the chair.—The histology of the endosperm during germination in *Tamus communis* and *Galium tricorne*, by Mr. Walter Gardiner, F.R.S., and Mr. Arthur W. Hill. After briefly describing the stages in the germination of *Tamus communis*, the authors gave an account of the histology of the endosperm and of the changes which accompany the dissolution of the cell walls.—Demonstration on the dimorphism of the Foraminifera, by Mr. J. J. Lister.—On the differentiation and integration of divergent series, by Mr. G. H. Hardy. The paper contains some discussion of the general principles in accordance with which we may attribute conventional values to analytical expressions which do not represent any determinate quantity when interpreted in the ordinary way. In particular it is shown how they lead to Borel's definition of the sum of a divergent series. It also contains investigations as to the possibility of applying the ordinary operations of the calculus to divergent series whose sums are defined as by Borel. A series of general theorems is proved, and applications are made to the evaluation of definite integrals and the theory of trigonometrical series.

PARIS.

Academy of Sciences, February 24.—M. Bouquet de la Grye in the chair.—On transcendental meromorphs defined by differential equations of the second order, by M. Paul Painlevé.—On the origin of stolonial formations, by M. Edmond Perrier.—On the impossibility of certain permanent states in viscous liquids, by M. P. Duhem.—M. Baillaud was elected a correspondant for the section of astronomy in the place of the late M. Souillart.—On some transformations of Backland, by M. E. Goursat.—The application of Duddell's singing arc to the measurement of small coefficients of self-induction, by M. Paul Janet. It is known from the experiments of Duddell that there is a simple relation between the period of the note given out by a singing arc, the capacity and the self-induction of the circuit. By measuring the intensity of the current with a thermal ammeter, the difference of potential with a thermal voltmeter, and working with condenser of known capacity, it is shown that coefficients of self-induction smaller than 0·003 Henry can be measured.—On a capillary electrometer, by M. Pierre Boley. The Lippmann capillary electrometer will not work with saturated liquid amalgams which are not sufficiently mobile in the narrow tubes. It has therefore been modified to meet this special case. Its sensibility was found to be of the order of ·00003 volt.—On some properties of azobenzene and hydrazobenzene, by MM. P. Freundler and L. Béranger. The Friedel and Crafts reaction cannot be utilised for the preparation of ketones from azo-bodies.—On the constitution of dibutylic and dicenanthylic alcohols, by M. Marcel Guerbet. By a careful study of the oxidation products of these two alcohols, it was found that they are represented by the formulæ $CH_3.CH(C_4H_9).CH_2.CH_2OH$ and $CH_3.CH_2.CH_2.CH(C_7H_{15}).CH_2.CH_2.OH$.—On the polymerised state of ordinary indigo and the isomeric transformation of indigotin into indirubin, by M. L. Maillard.—On some reactions obtained with the aid of magnesium amalgam, by M. L. Meunier. Magnesium amalgam attacks ethyl alcohol even in the cold, magnesium ethylate being formed. The alkyl iodides are more readily attacked by this reagent than by the copper-zinc couple, the saturated hydrocarbon being formed. Ordinary aldehyde reacts violently with magnesium amalgam, the symmetrical dioxybutane, $CH_3.CHOH.CHOH.CH_3$, being produced.—On the constitution of tariric acid, by M. Arnaud.—A new method for characterising the pseudo-acids, and on its application to the oximidocyanacetic esters, by M. P. Th. Muller. Measurements are made of the molecular refraction and molecular dispersion.—On some derivatives of methyl-nonyl-ketone, by M. H. Carette. By the addition of hydrocyanic acid to this ketone and the subsequent hydrolysis of the nitrile produced, the corresponding amide and acid were obtained, the properties of which are described.—On an important source of error in the examination of diastases, by MM. Emm. Pozzi-Escot. The colour reaction with tincture of guaiacum, which has been relied upon in many researches, is now found to fail in certain cases. From this it follows that a certain number of published works on the diastases and their localisation in particular cells are of no value.—On the analysis of ceramic products, by M. V. de Luynes.

For the analysis of objects in relief on porcelain of a different composition, advantage is taken of the action of a layer of drying glycerine in removing the surface of porcelain or glass.—Search for fatty acids in contaminated waters, by M. H. Causse. The amounts of fatty acids present in a water are regarded by the author as measuring the contamination, and methods are given for separating and estimating the quantities of such acids present.—The resistance of the red globules of the blood determined by its electrical conductivity, by MM. Calugareanu and Victor Henri. In the determination of the resistance of the red globules of the blood, it is necessary to determine both the hæmoglobin and the salts. This determination can be made with great precision by measuring the electric conductivity of the solutions. The application of this method has shown that the red globules may lose a part of their salts without any corresponding change in their colouring-matter.—On the simultaneous production of indoxyl and urea in the organism, by M. Julius Gnezda.—On asphyxia by the gases of drains, by M. Hanriot. Accidental cases of asphyxia in drains are usually attributed in the text-books to the presence of sulphuretted hydrogen. Analyses of the air in ventilated drains showed that this gas was either absent or present in such small proportion as to have no appreciable effect. In unventilated drains the amounts were larger, '03 to '05 per cent., but still too small to exert a poisonous action. The air in the unventilated drains was irrespirable on account of the large amount of carbonic acid present and the deficiency in oxygen, and hence no disinfectant that might be proposed would meet the case. The only practicable means of rendering the air of a drain inoffensive is energetic ventilation at the time the workmen are descending.—On the germination of Onguekoa and Strombosia, by M. Edouard Heckel.—On the tectonic of the neighbourhood of Biarritz, Bidart and Villefranque, by M. Leon Bertrand.—On the existence of phenomena of overlapping in the subbetic zone, by M. René Nicklès.—A geological map of Bambouk, in the French Soudan, on the scale of 1/250,000, by M. Alex. J. Bourdariat.—On the constitution of the suboceanic soil, by M. J. Thoulet.

DIARY OF SOCIETIES.

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—On the Spark Discharge from Metallic Poles in Water: Sir Norman Lockyer, F.R.S.—Experimental Researches on Drawn Steel. Part I. The Influence of Changes of Temperature on Magnetism. Part II. Resistivity, Elasticity and Density, and the Temperature Coefficients of Resistivity and Elasticity: J. R. Ashworth.—On the Effects of Magnetisation on the Electric Conductivity of Iron and Nickel: G. Barlow.—The Differential Equations of Fresnel's Polarisation-Vector, with an Extension to the Case of Active Media: J. Walker.—On a convenient Terminology for the various Stages of the Malaria Parasite: Prof. E. Ray Lankester, F.R.S.

LINNEAN SOCIETY, at 8.—On some New Species of Lepadidæ in the British Museum (Nat. Hist.): Prof. A. Gruvel.—On the Morphology of the Brain in the Mammalia, with Special Reference to the Lemurs, Recent and Extinct: Dr. G. Elliot Smith.

RÖNTGEN SOCIETY, at 8.30.—Localisation; with Demonstration of a Simple Direct Reading Apparatus: Dr. Barry Blacker.

CHEMICAL SOCIETY, at 8.—The Slow Oxidation of Methane at Low Temperatures: W. A. Bone and R. V. Wheeler.—Isomeric Additive Compounds of Dibenzyl Ketone and Deoxybenzoin with Benzal-*p*-toluidine, *m*-Nitrobenzalaniline and Benzal-*m*-nitraniline, Part III.: F. E. Francis.—Mesoxalic Semi-Aldehyde: H. J. H. Fenton and J. H. Ryffel.—*m*-Nitrobenzoylcamphor: M. O. Forster and F. M. G. Micklethwait.—Picrimidothiocarbonic Esters: J. C. Crocker.

FRIDAY, MARCH 7.

ROYAL INSTITUTION, at 9.—Radio-active Bodies: Prof. H. Becquerel.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. III. Devonshire: Dr. A. W. Rowe.

SATURDAY, MARCH 8.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—The Spiders of Epping Forest: Frank P. Smith.—Eolithic Implements from the Plateau Grave around Walderslade: J. P. Johnson.

MONDAY, MARCH 10.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Birmingham Sewage and its Treatment: F. R. O'Shaughnessy.—Remarks on the Technical Examination of Glue: E. G. Clayton.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geographical Conditions determining History and Religion in Asia Minor: Prof. W. M. Ramsay.

SOCIETY OF ARTS, at 8.—Photography applied to Illustration and Printing: J. D. Geddes.

TUESDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*:—Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin.

AERONAUTICAL SOCIETY (Society of Arts), at 8.—The Development of Aërial Navigation in Germany: Major W. L. Moëdebeck.—Balloon Photography: Miss Gertrude Bacon.—The Barton Airship: Dr. F. A. Barton.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Collection of Andamanese Objects, presented to the Museum, Royal Gardens, Kew, by P. Vaux, Esq.: Exhibited by Sir William Thiselton-Dyer, K.C.M.G., F.R.S.—The Nicobar Islanders: Extracts from Diaries kept in Car Nicobar by V. Solomons, Esq., 1895-1900: Communicated by Col. R. C. Temple, C.I.E.

WEDNESDAY, MARCH 12.

SOCIETY OF ARTS, at 8.—The Utility of Alkaline Phosphatic Manures: J. Hughes.

GEOLOGICAL SOCIETY, at 8.—The Crystalline Limestones of Ceylon: A. K. Coomára-Swámy.—Researches among some of the Proterozoic Gasteropoda which have been referred to Murchisonia and Pleurotomaria, with Descriptions of New Species: Miss Jane Donald.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.—Croonian Lecture on the Physico-Chemical Properties of Hæmoglobin, its Compounds and Derivatives: Prof. A. Gamgee, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned discussion on the following papers:—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts: A. P. Trotter.

MATHEMATICAL SOCIETY, at 5.30.—The Theory of Cauchy's Principal values (III.): Mr. G. H. Hardy.—The Solutions of a System of Linear Congruences: Rev. J. Cullen.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Indian Famine of 1899, and the Measures taken to meet It: T. W. Holderness.

FRIDAY, MARCH 14.

ROYAL INSTITUTION, at 9.—Magnetism in Transitu: Prof. S. P. Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Long Steel Wires in Surveying: H. J. Deane.

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